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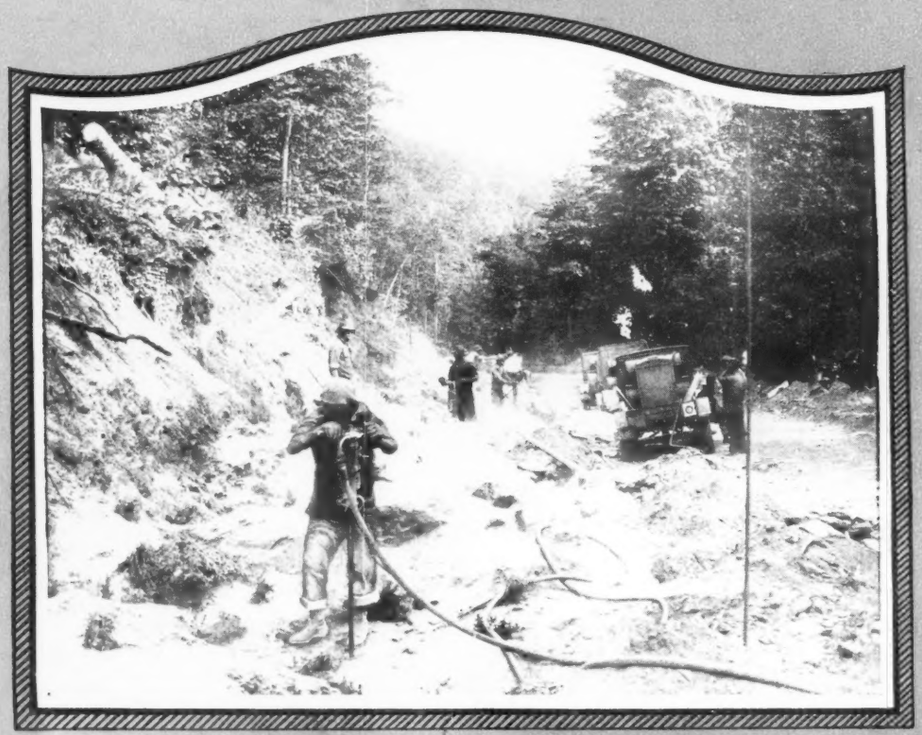


WIDENING THE FAMOUS MOHAWK TRAIL IN WESTERN MASSACHUSETTS WHERE SCENIC BEAUTY AND HISTORICAL ASSOCIATIONS ABOUND

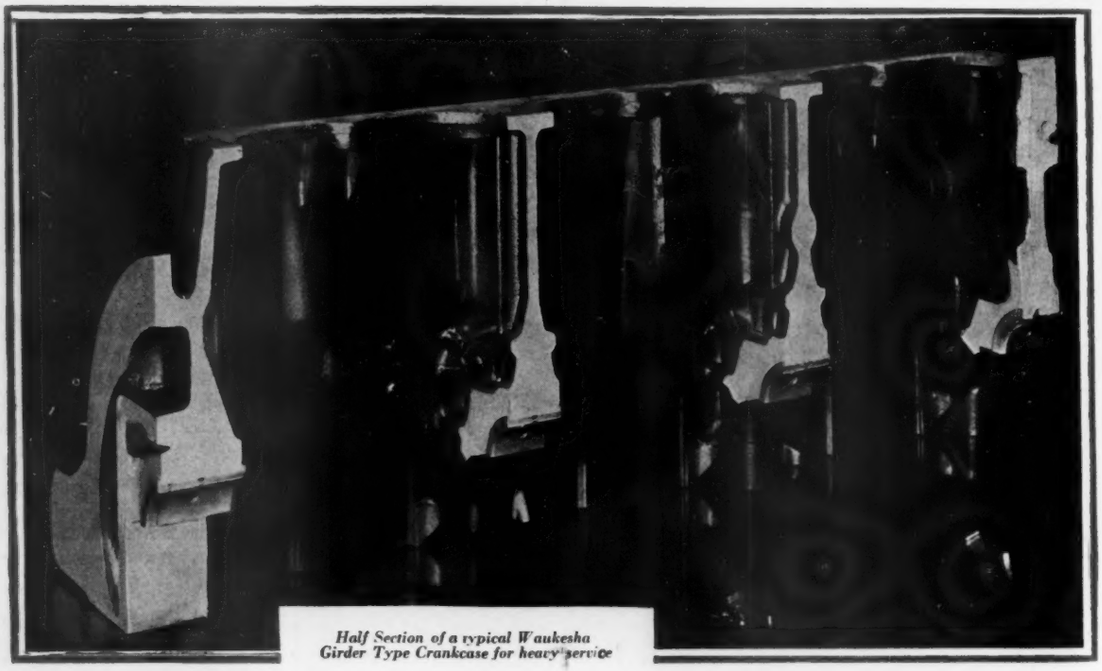
America Has Grown Air Conscious
R. Burdette Dale

Massachusetts Improving Scenic Mohawk Trail
A. S. Taylor

Water Stations in Arizona Desert
R. G. Skerrett

Work on Ambassador Bridge Goes Forward Rapidly
S. G. Roberts

(TABLE OF CONTENTS AND ADVERTISERS' INDEX, PAGE 26)



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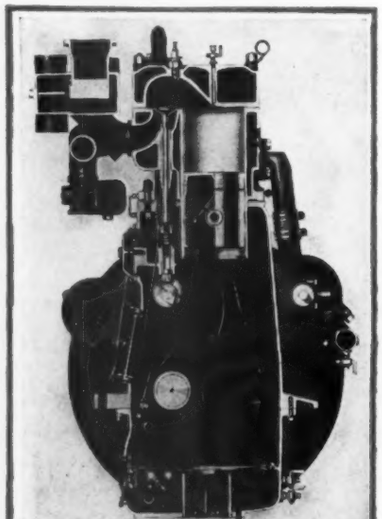

Cross Section of 4-cylinder Super-Duty Waukesha Engine

963

WAUKESHA ENGINES

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Scenic Mohawk Trail Being Reconstructed

This Highway Traverses a Historic Section of Massachusetts That Offers Much to the Touring Motorist

By A. S. TAYLOR

THE Mohawks are coming! The Mohawks are here!

Many times in the centuries gone, these cries spread through hamlets, villages, and lesser communities in western Massachusetts causing dismay or fierce and desperate resistance—such being the various reactions of other Indians and the white men to the nearness of those dreaded warriors.

The Mohawks were not inherently better or braver fighters than other red men of their day, but they were unhappily more effective because they were the first of America's Indian tribes to acquire firearms. The possession of guns gave them a great advantage over their tribal foes—armed as the other Indians were with only tomahawks and bows; and the Mohawks ruthlessly made the most of their superiority in weapons. When the Mohawks warred upon the white man, their stealthy methods of attack and their firearms made them doubly dangerous foes.

The Mohawks of New York and the Mohawks of Canada—the latter the cruel allies of the French—followed the same trail eastward from North Adams over the Hoosac Range in penetrating the territory lying between the Hoosac River and the Connecticut. Once over the crest of Hoosac Mountain the trail followed the Cold River to its confluence with the Deerfield, and thence along that stream to its juncture with the Connecticut. How long the Indians trod this trail will never be known, but there is reason to believe that the Mohawks used that path through the wilderness shortly after they arrived in New York, towards the close of the sixteenth century. Thereafter, for generations, they followed it in making war upon enemy Indian tribes; and the same trail served the Mohawks later on when they attacked the white men that had settled in the Valley of the Deerfield.

HISTORICAL associations and scenic beauty of many kinds combine to make the Mohawk Trail in western Massachusetts especially attractive to touring motorists. By one route or another, a trail was blazed by the Indians centuries ago across the mountains that separate the Valley of the Hudson River from the far-flung watershed of the Connecticut. The pioneering white man followed some of these trails when he built roads that ultimately crossed Hoosac Mountain and made vehicular intercourse possible between the contiguous sections of New York and Massachusetts.

The Mohawk Trail of today was not undertaken before 1911, and was not made fit for motor traffic prior to 1917. It is now undergoing extensive reconstruction; and the present article describes how this work is being done.

The Mohawks of New York and the Mohawks of Canada were friendly to each other; but the Mohawks of New York were embittered towards the French, while the Mohawks of Canada were equally hostile towards the British. We have only to recall that the Valley of the Deerfield ran more or less parallel with the line of outposts or forts erected by the British to defend their northern border against incursions from the French who were, for a considerable period, bent upon dominating the country. Between 1689 and 1763—an interval of nearly three quarters of a century, France and England were engaged in America in four conflicts, in which the Indian allies played no small part. First there was King William's War, from 1689 to 1697; then followed Queen Anne's War, from 1703 to 1713; next, there was King George's War, from 1744 to 1748; and, finally, the Seven Years War, from 1756 to 1763.

With the conclusion of the Seven Years War, the settlers in western Massachusetts enjoyed a period of virtual peace until the beginning of the Revolution, when the Mohawk Trail was trod by the shod feet of patriots hastening to intercept the British forces coming southward by way of Lake Champlain. Then it became the vital pathway of Colonial troops determined to establish for all time their independence of royal control. How effectively the trail aided at critical moments in that prolonged conflict is a matter of historical record, and need not be recounted here. It is enough for us to know that the Mohawk Trail—then a mere footpath, probably not more than 18 inches wide—blazed the way for the first rough road constructed over Hoosac Mountain in 1753. That road was built for the passage of carts drawn by horses and oxen, and for much of the way held to the line of the Indian trail.

Other roads were constructed subsequently, notably the Turnpike that provided a route for the stages that carried passengers and postal matter over those towering hills before that natural barrier was pierced by the Hoosac Tunnel. The present Mohawk Trail was authorized by the Legislature of Massachusetts in 1911, when $75,000 was appropriated for the construction and improvement of a highway over Hoosac Mountain between the

Left—The rear section of this house was the first dwelling in Charlemont, settled in 1742. The structure contains timbers hewed and squared by Capt. Moses Rice, the pioneer settler of the town, and was the boyhood home of Charles Dudley Warner, the author. Right—Monument erected at a strikingly scenic point on the Mohawk Trail in memory of the brothers of the Massachusetts Elks Association who died in the World War.

City of North Adams on the west and the Valley of the Deerfield on the east. In 1912, an additional $75,000 was appropriated, making a total of $150,000. It is this highway of rare scenic charm that has since been traveled by hundreds of thousands of tourists.

Nathaniel Hawthorne thus wrote after a ride over the Mohawk Trail of his day: "Often it would seem a wonder how our road was to continue, the mountains rose so abruptly on either side, and stood so directly a wall across our onward course; while looking behind, it would be an equal mystery how we had gotten thither, through the huge base of the mountain that seemed to have reared itself erect after our passage. Between the mountains there were gorges that led the imagination away into new scenes of wildness. I have never driven through such romantic scenery where there was such a variety and boldness of mountain shapes as this, and though it was a bright sunny day, the mountains diversified the view with sunshine and shadow, and glory and gloom". The physical charms of a journey over Hoosac Mountain are still present along the existing highway even though it traces a somewhat different course than did the road over which Hawthorne traveled.

Much of what we now know of the historic Mohawk Trail, trodden by the moccasined feet of Indians, is due to the work done with historical enthusiasm by the late Judge John A. Aiken; and thanks to his labors and to those of others inspired by him we know certainly that the road of today follows closely and extensively the route pursued by the Mohawks and other Indians in making their way through the Berkshires from the Hudson to the Connecticut.

The Mohawk Trail, as laid out by the State of Massachusetts in 1911, extends from Greenfield westward to North Adams, a distance of substantially 34 miles; and all along its course are reminders of Colonial days and of the struggles of the pioneers to establish themselves in the region. The road authorized in 1911 was not intended primarily for motor traffic; but the appeal that it made to autoists, and their increasing use of it, compelled the State and contiguous communities to contribute to the construction of a thoroughly modern highway, which was started in 1917. This work has been in progress intermittently ever since; and more than $1,000,000 has been obligated for the improvement of this extremely picturesque mountain route. Most of the operations at present in hand are along sections lying between the Town of Charlemont on the east and the City of North Adams on the west.

The motor road built since 1917 runs for a considerable distance westward along the Deerfield River; but just west of Charlemont the new Mohawk Trail swings away from that stream and parallels the precipitous Cold River. It is throughout this stretch that long and steep grades are encountered. The road as first constructed contained numerous sharp curves; and the work now underway is designed to reduce the gradients wherever practicable and to ease the curves while incidentally widening the highway. The im-

Top—Mr. L. W. Sears, of Charlemont, and one of the stones set up in the grist mill built there in 1753. Left—This old wooden bridge across the Deerfield at Charlemont is near the fording place used for centuries by the Indians and the white men. Right—Concrete bridge over the Deerfield. This bridge is part of the Mohawk Trail.

1—Truck-mounted portables providing air for "Jackhamers" drilling rock on that part of the Mohawk Trail upon which D'Onfro Brothers, Inc., are working. 2—Block-holing a boulder with an R-12 "Jackhamer" on the section being built by the Lane Construction Corporation. 3—Close-up of an R-12 "Jackhamer" block-holing a large piece of blasted rock. 4—Where the Lane Construction Corporation is drilling deep holes with an X-71 drill in widening a steep stretch of the road. 5—Section of the trail between the Hair Pin Turn and the western crest, showing where 4,000 cubic yards of rock are being removed.

provements in progress are embraced in two contracts awarded, respectively, to the Lane Construction Corporation of Meriden, Conn., and to D'Onfro Brothers, Inc., of Leominster, Mass.

The Lane Construction Corporation's contract begins at Main Street in North Adams, at the western end of the Mohawk Trail, and follows the trail thence into Clarksburg and on up the mountainside into the Township of Florida—a distance of 6⅓ miles. The contract of the D'Onfro Brothers starts at the farther end of the bridge over the Deerfield just west of Charlemont, continuing from that point along the Cold River and up into the mountains for about 9½ miles—terminating just east of Whitcomb Summit.

The Lane Construction Corporation commenced operations last fall and worked for three or four weeks before the weather called a halt. The D'Onfro Brothers started work this year by moving in machinery in March, but some snow and a great deal of rain made systematic effort impossible until after the close of April. Both contracts specify that the road shall be ready for traffic on November 2, 1929. Despite the time lost early in the year, both contractors have made excellent headway, and there is every reason to believe that the trail will be open to the motorists on the date set by the Department of Public Works of the Commonwealth of Massachusetts. The progress made is largely due to the utilization of labor-saving machinery, including portable air compressors, pneumatic rock drills, and other air-driven facilities.

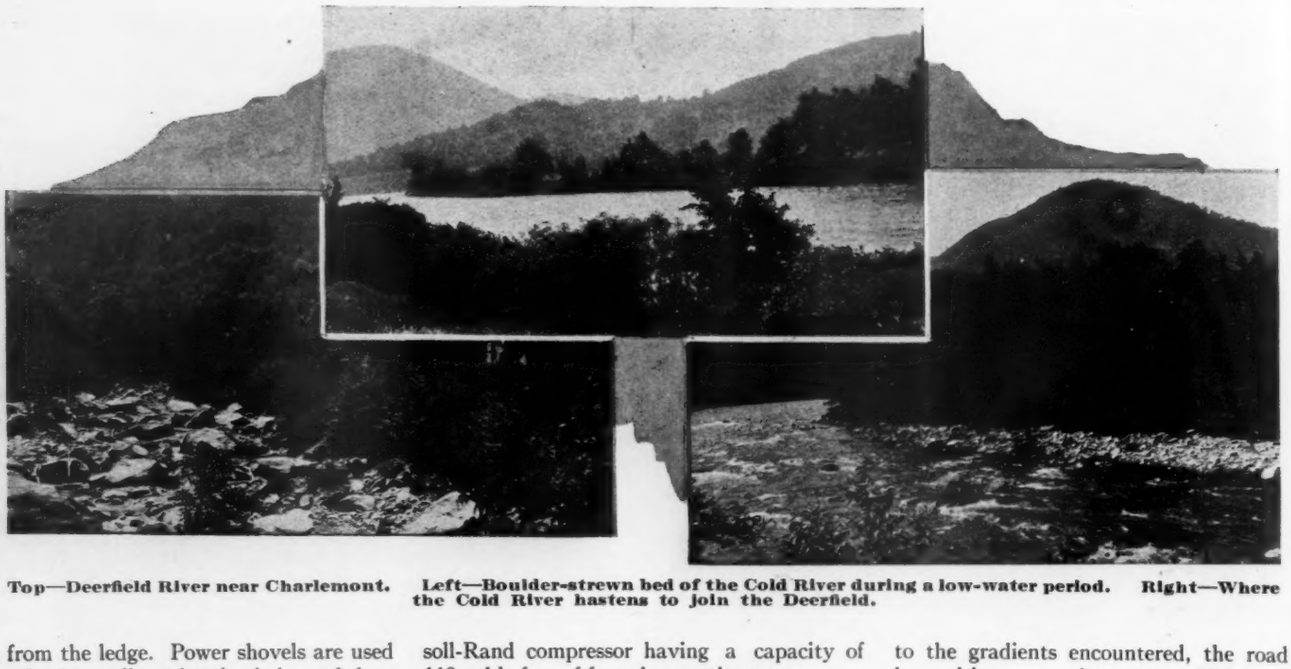
Those who have had the pleasure of traveling over the Mohawk Trail know that the most spectacular section of it is the slope leading directly up to the Hair Pin Turn and from there on to the western crest of the trail where the roadway tops Hoosac Mountain and offers an expansive view of great and exceptional beauty. It is between the Hair Pin Turn and the top of this climb that the Lane Construction Corporation is excavating 4,000 cubic yards of rock in widening the road and in easing the grade wherever practicable. In removing this rock, the holes have a maximum depth of 24 feet; and Ingersoll-Rand X-71 tripod drills are used for this purpose. Block holes and shallow holes are drilled with R-12 "Jackhamers". Mr. George Parker, who is in charge of blasting and getting out rock, emphasizes the fact that not a drill steel has been lost in the ledge this year. Four portable air compressors, mounted on trucks, furnish the air for driving the rock drills. These units are extremely mobile. The blacksmith shop at the Hair Pin Turn is equipped with a No. 34 sharpener.

All told, the Lane Construction Corporation will be required to excavate 17,000 cubic yards of earth and 12,000 cubic yards of ledge, as well as 1,000 cubic yards of ordinary borrow, complete in place. The contract includes the placing of culverts, the building of retaining walls, the erection of cable guard rails, and the doing of various other things essential to completing the job. The total contract price for the work is $230,000. The road will have a 7 per cent grade between the Hair Pin Turn and the crest, and will be 24 feet wide on the straightaway stretches. On the Hair Pin Turn it has been widened to 44 feet and on other curves the width will be not less than 28 feet. Like the rest of the improved trail, this stretch will have a bituminous-macadam surface. The contract will probably be completed by November 2, the date specified. Mr. A. L. Brown is superintendent for the Lane Construction Corporation.

The contract under which the D'Onfro Brothers are working specifies that a total of 60,320 cubic yards of earth and ledge shall be removed in straightening and widening the highway; and of this amount 32,650 cubic yards is rock calling for drilling and blasting. On the section between the Cold River bridge and Brown's Corner, a distance of 2 miles, the excavating consists substantially of 100 per cent rock; and within this stretch the maximum grade is 7½ per cent. This gradient indicates in a general way the difficulties involved in disposing of the rock after it has been broken

Top, left—Section of the Mohawk Trail with the rock sub-base for half of the new road in position. Right—Blasting a rocky wall to widen the trail below the western crest. Bottom, left—Blacksmith shop of the Lane Construction Corporation, showing the No. 34 sharpener reconditioning drill steels. Right—A fine example of skilful drilling: a wall of rock flanking the trail between the Hair Pin Turn and the western crest.

1—Cold River at low water just above the point where the stream pours into the Deerfield. 2—Here the Mohawk Trail crosses the Deerfield west of Charlemont and starts its long, steep climb up the Cold River Valley. 3—The Hair Pin Turn. At the left the road mounts at a 7 per cent grade to the western crest of the Mohawk Trail, and at the right it descends into North Adams. 4—The climb a short distance west of Greenfield, looking north and eastward over broad reaches of cultivated bottom lands. 5—A bit of the Mohawk Trail where D'Onfro Brothers, Inc., are widening the road in the Cold River Valley.



Top—Deerfield River near Charlemont. Left—Boulder-strewn bed of the Cold River during a low-water period. Right—Where the Cold River hastens to join the Deerfield.

loose from the ledge. Power shovels are used to handle the spoils and to load the rock into capacious motor trucks that move it thence to the dumping points. The roadway, when finished, will be generally 24 feet wide, but it will have a maximum width of 40 feet on some of the curves. For half a mile on Dead Man's Curve the retaining wall is 15 feet high and 12 feet thick to insure ample support to the highway where it runs along the sharp slope of the mountainside.

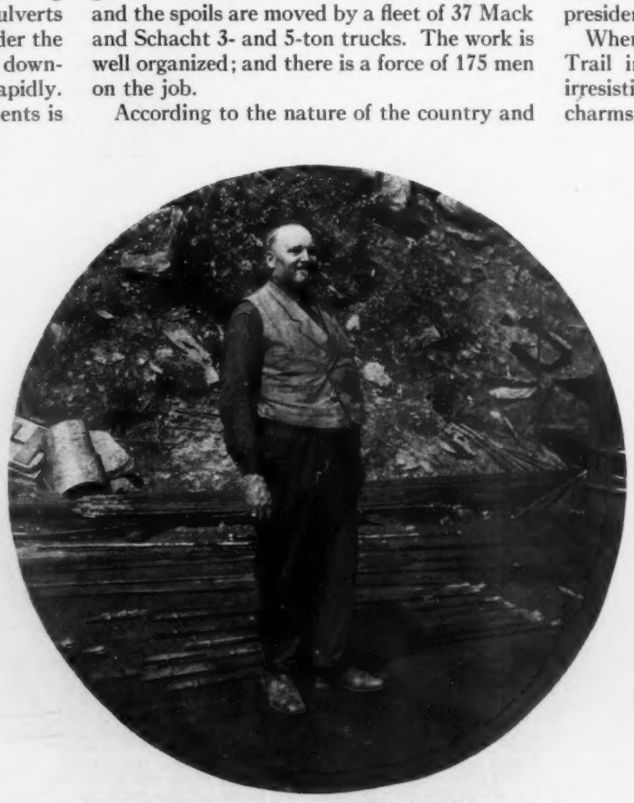
In addition to the excavating just referred to, the D'Onfro Brothers are required to dig 3,000 cubic yards of trench for culverts through which water will be carried under the road to adjacent ravines during heavy downpours or when snow may be melting rapidly. Most of the material for the embankments is being obtained from points where rock and earth are removed in widening the right of way—the remainder, an aggregate of 14,245 cubic yards of earth and gravel, must be secured from borrow pits. Stone for walls, rip-rap, and rock embankment comes from the excavations; but all stone used to form the road sub-base is taken from the river bed.

In clearing away rock, the D'Onfro Brothers, Inc., are doing all drilling with S-49 "Jackhamers"; and Mr. Daniel A. D'Onfro, treasurer of the company, speaks enthusiastically of their performance. They have about a dozen of them in service; and in the course of a day the drills make a total footage of 1,000 feet. The "Jackhamers" use Ingersoll-Rand drill steels, of which something like 1,000 are conditioned daily. For this purpose the blacksmith shop is equipped with two No. 34 I-R sharpeners and a No. 25 oil furnace. Part of the blacksmith shop is mounted on a trailer which also carries an Ingersoll-Rand compressor having a capacity of 110 cubic feet of free air per minute.

Operations are in hand at several places within the scope of the D'Onfro Brothers' contract; and to furnish air for the "Jackhamers" there are seven Ingersoll-Rand portable compressors, each of 110 cubic feet capacity per minute. Owing to the comparatively short time available for the completion of the job, it is the contractor's practice to carry on until midnight—flood lights serving to illuminate the work. Three steam and two gasoline shovels of Erie make are in service; and the spoils are moved by a fleet of 37 Mack and Schacht 3- and 5-ton trucks. The work is well organized; and there is a force of 175 men on the job.

According to the nature of the country and to the gradients encountered, the road will have either a gravel or a stone-fill foundation. In either case, the uppermost course will have a bituminous-macadam surface 2½ inches thick after rolling. The first application of the asphalt will be at the rate of 2½ gallons per square yard. From sub-base to surface, the roadbed will have a finished vertical thickness of 16 inches. The section of the Mohawk Trail embraced by the D'Onfro Brothers' contract will involve a total outlay of $452,000. The D'Onfro Brothers have been in business since 1904; and Nicholas M. D'Onfro is president of the organization.

When again opened to traffic, the Mohawk Trail in its improved state should make an irresistible appeal to motorists seeking scenic charms. The trail will then be able to accommodate a much larger volume of traffic and will be able to do this with greater comfort and a marked increase in safety because of the protective provisions at points where the route either hangs on the mountainside or, necessarily, makes more or less abrupt turns. Both the Commonwealth of Massachusetts and the interested communities along the trail are to be congratulated and thanked for what they are thus doing for the benefit of the touring public.



Daniel A. D'Onfro, treasurer of D'Onfro Brothers, Inc.

A new airplane thermometer, which automatically records the minimum temperature of the air through which a plane is passing, has been designed by H. B. Henrickson of the United States Bureau of Standards. The instrument makes use of bimetal strip and is mounted on one of the struts. In fact, a number of these thermometers were carried in this way by Capt. A. W. Stevens during his recent high-altitude flights at Wright Field, Dayton, Ohio.

Water Stations in Arizona Desert

Oil-Engine Compressors Raise Water from Deep Wells for Locomotives of the Southern Pacific Lines

By R. G. SKERRETT

PHOENIX, Ariz., has been fancifully described as "The Cinderella of the Southwest"; and the phrase is a befitting one because this attractive and progressive city has come into her own and today wears the "slipper of recognition" that belongs to her of right. No small part of this nation-wide recognition is due to what the Southern Pacific Company has done to make Phoenix more accessible to the traveler.

Before we describe this engineering work that put Phoenix on the main line of the famous transcontinental Sunset and Golden State routes of the Southern Pacific, it might be of interest to tell something of the origin of Phoenix and its development. We shall abstract freely from a colorful folder issued by the Phoenix Chamber of Commerce. Let us quote:

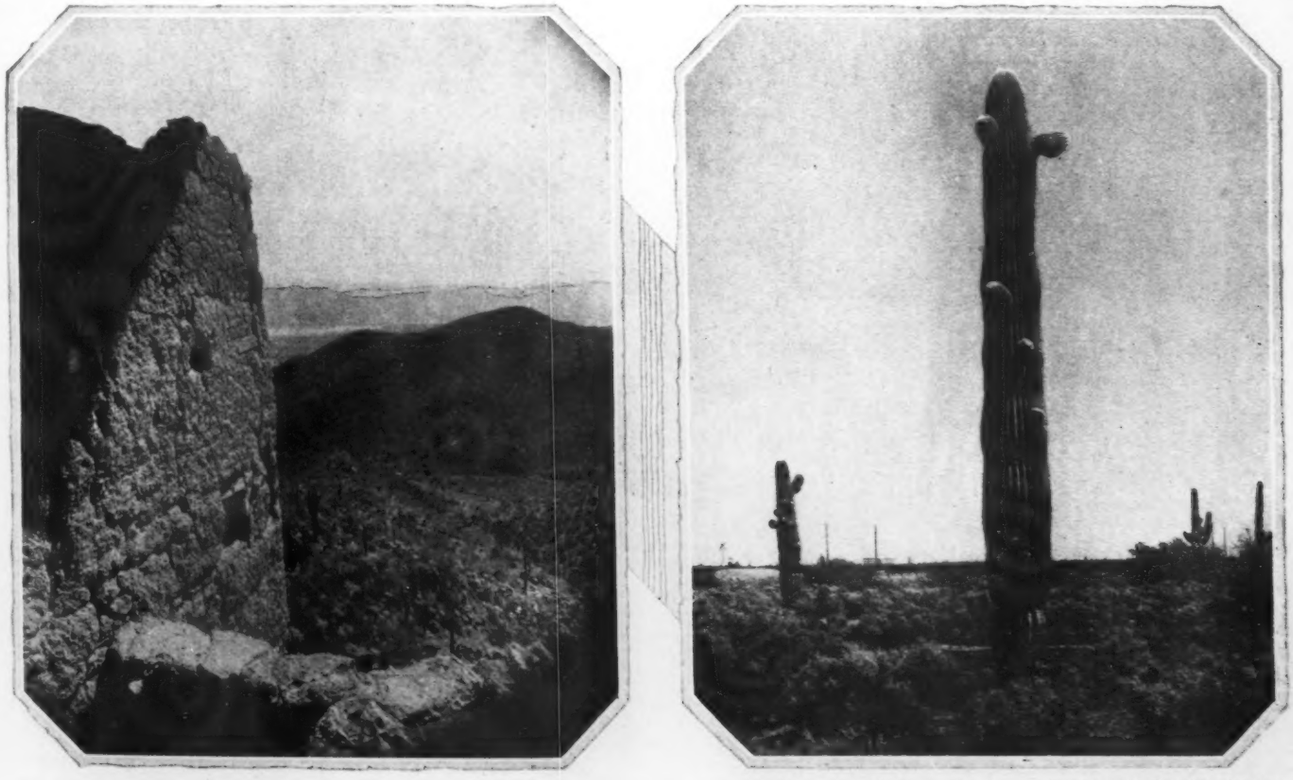
"The present growth and development of Phoenix and the Salt River Valley is but the climax of a perfectly logical development. About 1867, a few settlers began to gather about Helling's Flour Mill, which was just being built in the midst of a group of prehistoric Pueblo ruins and intricate prehistoric irrigation canals. Scientists assert that in 275 B.C. the ancient unknown builders were using 230 miles of these ditches to water 96,000 acres of rich farming land.

"Jack Swilling, a picturesque, long-haired, far-seeing pioneer, took the hint given by the old canals and organized the Swilling Canal Company. In 1867, they started the first modern ditch, using the lines of the ancient system. It fell to the lot of Darrel Duppa, a wild, mysterious, English nobleman, a member of this canal company, to name the new settlement. This he did with a classic flourish by declaring that from ashes of the past, like the Phoenix Bird of old, a glorious city would spring up in this ancient setting and that it should be called 'Phoenix'.

"The settlers, about 300 in number, met October 20, 1870, appointed Darrel Duppa to lay out a townsite, and Capt. W. A. Hancock to survey it. Patent was received April 10, 1874. About that time corner lots were sold for $11, and inside lots for $7. Today, these same lots are selling by the front foot, and are actually bringing from $50,000 to $70,000 per lot.

"Phoenix was not incorporated until February 25, 1881. The first railway into Phoenix was completed in 1887, and was called the Maricopa & Phoenix. That line was subsequently supplanted by the main line of the Southern Pacific. The modern city of Phoenix may be said to have had its beginnings on April 7, 1914, when it adopted the commission form of government. Its rise since that date has been steady and rapid." Phoenix now has a population of fully 60,000; and it is an attractive and typically up-to-date municipality. The state has ample warrant for the pride it manifests in this her most bustling and largest city.

Despite her many charms and the fact that she was the most populous community in Arizona, still Phoenix lay off the beaten tracks of travel until the latter part of 1926. That is to say, while Phoenix could be reached by the Southern Pacific or by the Santa Fe, to do so it was necessary to leave the main lines of these transcontinental railroads and to cover the rest of the journey on one or the other of the branch lines available. America's pampered public all too often declined to make the change, and for years an enormous percentage of her tourists passed Phoenix well to the north or south, and only relatively few of this sightseeing crowd turned aside to look upon

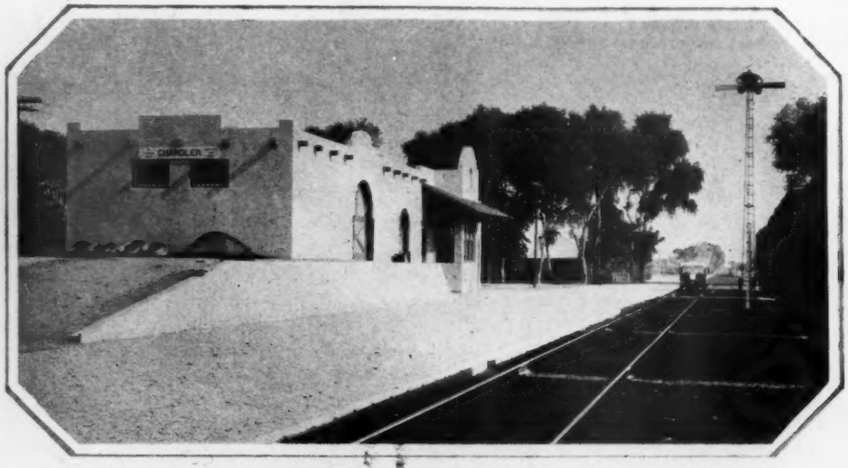


Southern Pacific Photo Service

Left—The remnant of an ancient cliff dwelling once occupied by the aborigines of Arizona. Right—A giant suhuar, a towering and grotesque species of cactus that flourishes in the arid sections of Arizona.

Phoenix and the many things she has to offer them. This situation has been completely altered through the generosity and business foresight of the Southern Pacific Company.

Phoenix is the center of a man-made area of agricultural riches. It is in the middle of a fruitful oasis where the date, the olive, the orange, the lemon, and the grapefruit flourish—thanks to artificial waterways and the widespread distribution of a beneficent flood which, combined with a fertile soil and abundant sunshine, has turned the desert into very productive farmlands. But fertile acres alone are not profitable unless the fruits of the farmer's toil can reach readily a receptive and compensating market. This has been the function of the railroads; and their responsibility in this respect has increased as the tributary country has developed.



Chandler, on the new main line of the Southern Pacific, is a noted health center because of the abundance of its curative sunshine.

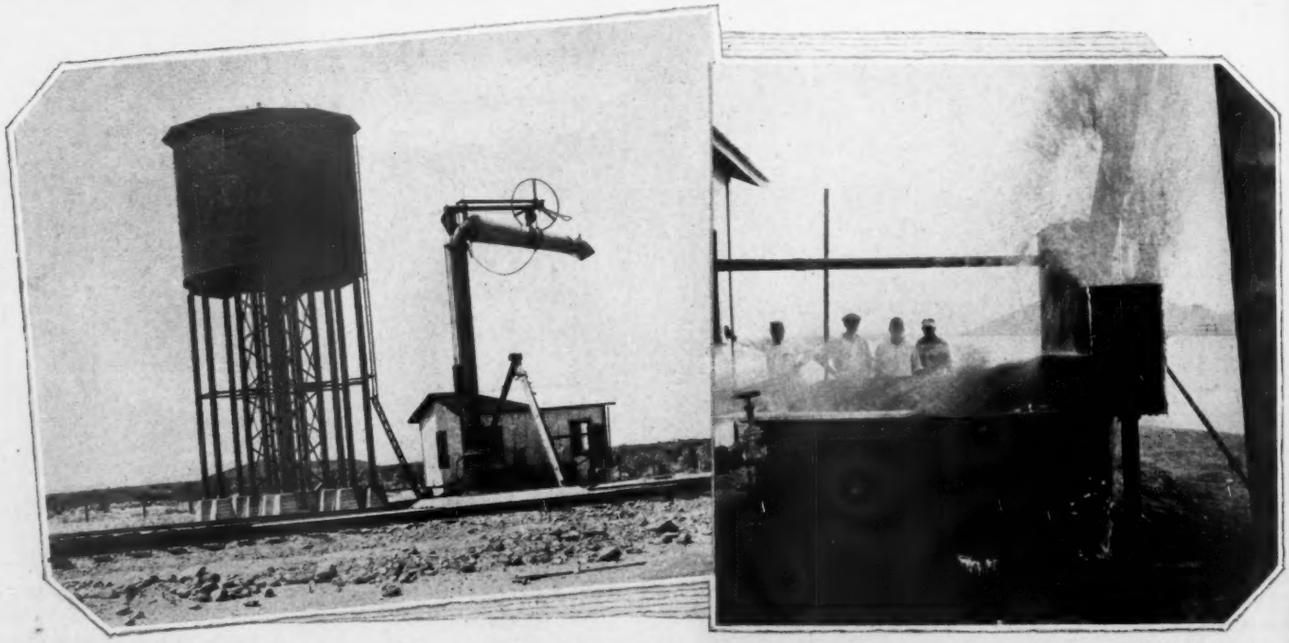
The railroads of the Southwest opened up the country by moving into it settlers and by laying tracks into areas which needed only water and man to make them productive. The very first of the Federal reclamation projects of the United States are located in Arizona and neighboring New Mexico. Virtually all these have been outstandingly successful. Phoenix, as the focal point of Arizona's agricultural wonderland, quite naturally deserved more adequate transportation facilities; and, with this thought in mind, the Southern Pacific Company set about constructing a second main track line that would directly link Phoenix with the tracks of its well-known Sunset and Golden State routes—that is to say, make Phoenix a station point on its main-line system.

Without going into details, it will suffice to state that the new route taps the old main line at Picacho, swings north and west to Phoenix, and from Phoenix runs westward to Wellton where it merges again with the old main line. All told, the improvement has called for the construction of 163.72 miles of new line and the reconstruction of 63.62 miles of old line—a total betterment covering a distance of 227.34 miles. While the new route is 42 miles longer than the old one, the grades and curvature on the new line are enough better virtually to offset the additional distance to be run.

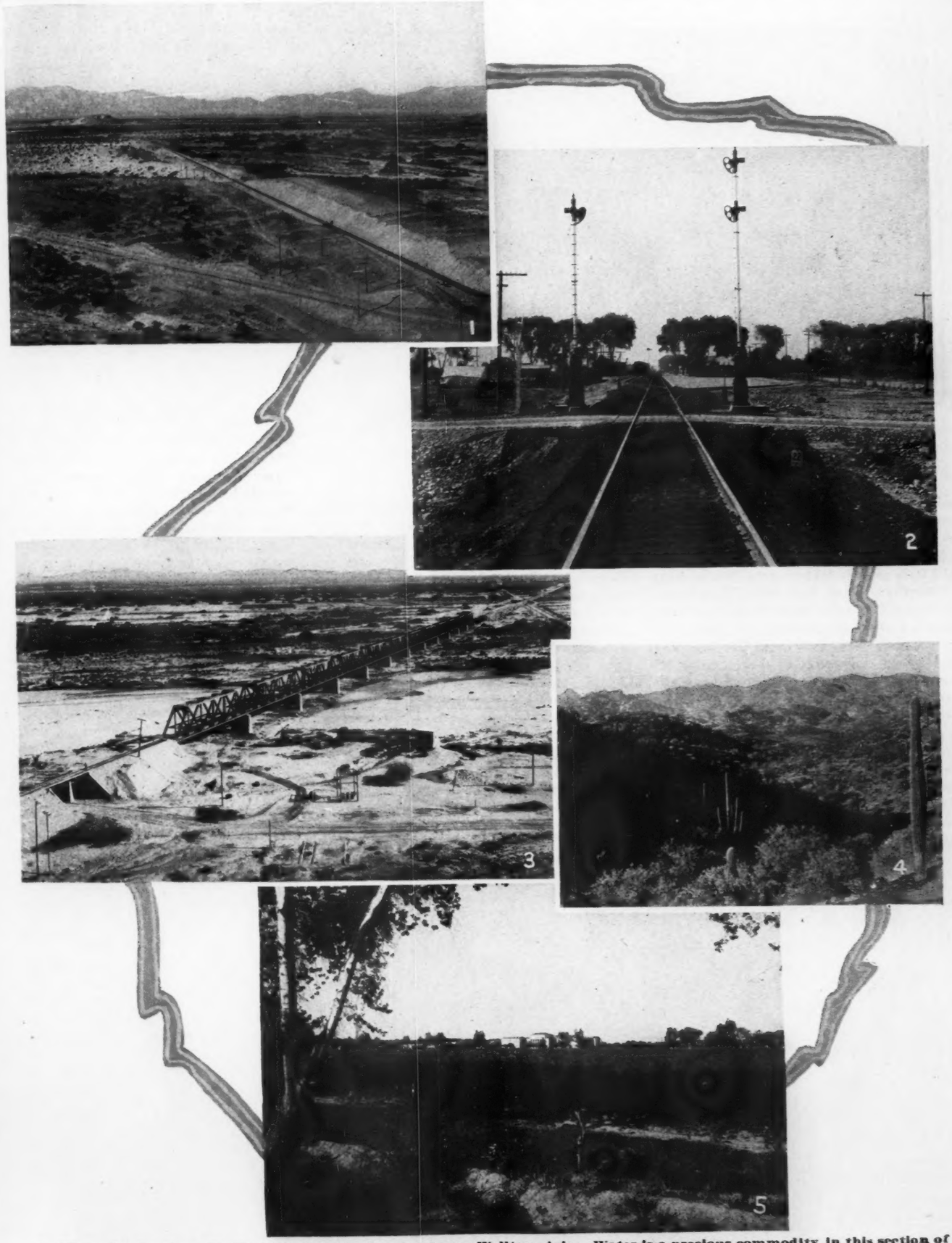
The work has necessitated the building of a number of bridges—most of them spanning the beds of waterways that are dry except for comparatively brief periods yearly. During these stages of flood water, however, the bridges have to be able to withstand the violently destructive sweep of the short-lived streams. Therefore, in order to give the bridges sufficient strength, to plant their foundations on firm ground, it was necessary to penetrate the river bottoms at points as deep as 100 feet below rail base. The foundations were carried down by a pneumatic process.

Operations in connection with the construction of the new line were started at Picacho on January 6, 1925; and the entire project was completed and turned over for service on November 1, 1926. As a matter of fact, however, the first trains over the route entered Phoenix on October 15, 1926; and the occasion was very properly made one of public rejoicing, and was celebrated with appropriate ceremonies. In this, not only the people at Phoenix but dwellers in the adjacent territory participated.

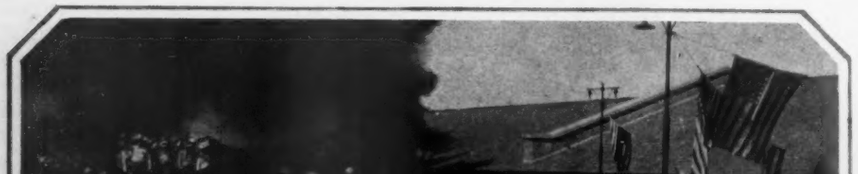
The total grading on the line from Picacho to Phoenix and thence to Dome—18.31 miles west of Wellton, involved the handling of 2,700,000 cubic yards of earth, 385,000 cubic yards of solid rock, and 510,000 cubic yards of cemented material. The work from Picacho to Pozo was done by C. E. Crowley of Los Angeles; the grading between Hassayampa and Wellton was done by the Utah Construction Company; and the grading for the double-tracking between Wellton and Dome was done by C. E. Crowley. In its entirety



Left—Pumping station and water tank at Arlington, Ariz., equipped with an oil-engine compressor plant. Right—Water for train service being raised from the deep well at Arlington by means of an air lift



1—Where the Southern Pacific Lines traverse the desert near Wellton, Ariz. Water is a precious commodity in this section of the state. 2—Looking toward the station at Chandler, Ariz. Irrigation has transformed this naturally arid region. 3—Gila River Bridge near the west end of the new route of the Southern Pacific Lines in Arizona. 4—Typical country in a mountainous section of Arizona where very little water falls in the course of a year. 5—Chandler High School seen on the far side of a flourishing field of cotton, indicating what water will do in sunny Arizona in transforming desert lands.



How they celebrated at Phoenix, Ariz., when the first train over the new route of the Southern Pacific Lines entered the city.

the improvement entailed a very considerable expenditure; and the undertaking was under the supervision of George Boschke, chief engineer of the Southern Pacific.

We have already said that the development of Phoenix and the Salt River Valley was fundamentally due to skillful irrigation. The railroads traversing the country depend upon steam locomotives to do the hauling; and steam locomotives require water, and good water at that because their boilers are sensitive to the presence of anything in the water that will induce the formation of scale and the promotion of priming. Railroads cannot count upon irrigating canals to provide them with this essential water, because they often cross arid stretches that are more or less remote from such sources of supply. Therefore, they are obliged in such situations to create—at strategic points—water stations that draw their water from deep wells. On the new route that has put Phoenix on the main line there are six locomotive water stations. Three of these are located between Hassayampa and Wellton and, therefore, they are west of Phoenix and in the desert region. One is at Arlington, 45.7 miles beyond Phoenix; the second is at Saddle, 20.3 miles farther on; and the third is at Kofa, 38.5 miles westward of Saddle. Saddle is at the summit of the Gila Bend Mountains, which lie between Yuma and Phoenix.

The water at the foregoing locomotive water stations is elevated from levels about 450 feet below the ground surface; and the engineers of the railroad decided that the pumping could be done more economically if the wells were equipped with air lifts for this work. Furthermore, because of the isolated positions of the water stations, it seemed highly desirable to equip each with its own power plant for the operating of the required air compressors. Owing to the fact that the locomotives on the line are oil fired, there seemed to be the best of reasons for using oil-engine prime movers. The problem was solved by placing in each station a 55-hp. direct-connected POV-2 oil-engine compressor capable of utilizing the same fuel oil that is burned under the boilers of the locomotives. This operating fuel costs 3.5 cents a gallon. The engines are of the 4-cycle, solid-injection type—a type that has been successfully used by the Ingersoll-Rand Company in the development of the oil-electric locomotive and for marine and industrial purposes.

The output from each well averages 80 gallons a minute; and the units are operated from ten to twelve hours daily—depending upon conditions. This is sufficient to take care of the locomotives' needs and to provide water for local consumption. At Arlington and Saddle the water is fair and suitable for locomotive use; but that at Kofa is not fit for locomotive boiler feed and, accordingly, the pumping plant is operated only two or three times a month in order to maintain a supply to meet station requirements. This merely illustrates some of the difficulties confronting a railroad traversing a country where soft surface water is not available for the steam locomotives. Ground water in such a region is apt to be alkaline; and in the case of the deep well at Kofa the water has proved prohibitively so for locomotive use.

The feature of these installations of particular interest to the readers of this magazine is that the air lift is especially suited for pumping water under the conditions prevailing at the three stations in question. The reason for this is that the well equipment is extremely simple—there are no moving parts subject to the erosive action of sand carried by the water, reducing the upkeep charge accordingly; and the air lift, in such circumstances, has distinct advantages over other types of pumps. The air-lift plants have performed admirably and have given complete satisfaction. The average operating air pressure is 110 pounds; and the oil-engine units have furnished the needful air at a cost of from $16.75 to $20.55 for fuel oil per month—the total outlay depending, in each case, upon the volume of water pumped during the period.

The traveler, who generally thinks of his own comfort and is fussy when his train may lag a few minutes behind the schedule, seldom knows of the prevision that must be exercised by a railroad in providing facilities designed to neutralize the difficulties interposed by Nature. He little realizes that the powerful locomotive at the head of his train is extremely sensitive to bad water, and that, in any case, ample water must continually be at hand in order that the engine can develop the required power and cover mile after mile at goodly speed, no matter what may be the character of the country traversed. In what has been said previously in this article, we see how the Southern Pacific Company has endeavored, and with success, to offset perhaps the worst handicap imposed by the desert.

Radio putting an engineering construction camp, in the wilds of Arizona, in touch with broadcasted music and vocal entertainment.

Unbalance in Running Machinery Can Be Quickly Located

THERE has been a general tendency during recent years to increase the speed of machinery for good and sufficient reasons. This engineering trend has led to the development of balancing methods that can be utilized effectively in reducing or eliminating in the process of manufacture the probability of vibration in high-speed units when placed in service. Today, regardless of size, any well-built machine is expected to operate smoothly throughout its entire speed range.

Success in this is due to greater care in designing and to higher skill exercised in the course of construction. An aid to this end is the balancing machine, of one type or another, now in widespread use. This machine is employed to balance rotors before they are mounted in their bearings; and this procedure makes it possible usually to assure excellent performance in the finished product. There are cases, however, in which the balancing machine cannot be utilized or can be employed only to a restricted degree. These cases can be classified as follows:

Where it is more expedient or quicker to balance a rotor after it has been assembled in its bearings and run under its own power.

Where a balancing machine has been employed but where some vibration develops in the finished product, possibly due to the speed of rotation being higher than when tested in the balancing machine or to a temperature condition that is met only in actual service.

Where trouble has developed after a rotor has been in service for some time, possibly caused by the shifting of some part of the rotor.

The Davey dynamic balancing equipment has been designed especially to deal with situations arising under any one of the circumstances outlined in the foregoing three classes of defective or deranged balance; and this apparatus can be attached to machines ranging from the largest turbines down to units of only fractional horsepower. The outfit, which weighs but 20 pounds complete with batteries, is supplied in a portable case for hand carriage.

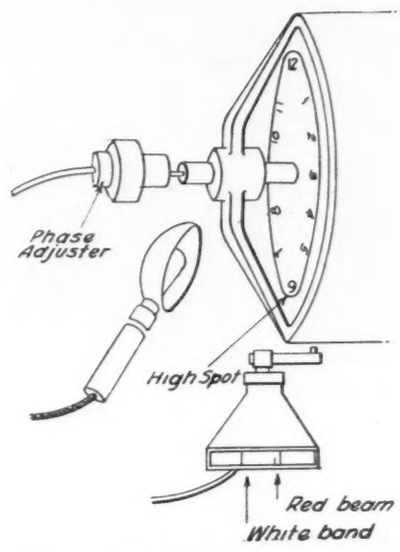


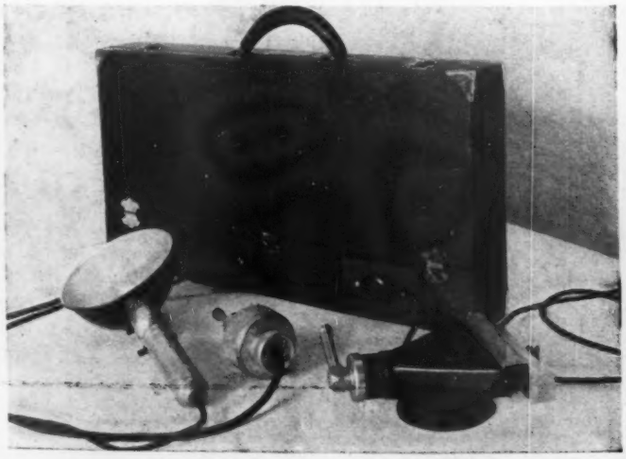
Diagram illustrating manner in which the Davey apparatus operates in making a balancing test.

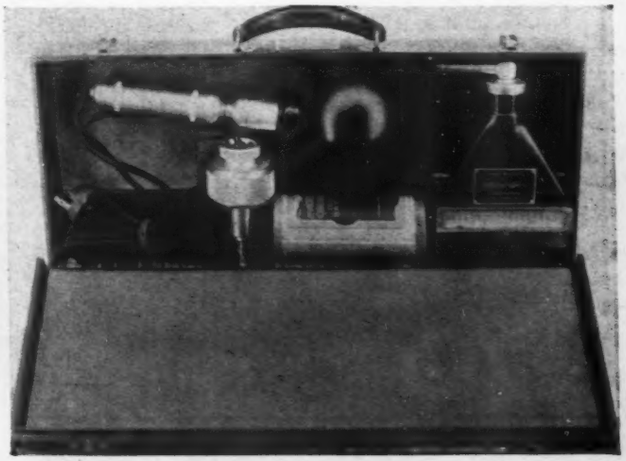
The Davey equipment consists of a hand lamp in which is fitted a special neon tube that provides a red light, a phase adjuster, and a vibrometer. When the vibrometer arm is in contact with the frame of a machine in motion, the vibrometer indicates not only the amount of vibration but also the path of vibration in relation to the revolution of the rotor. The amplitude of the vibrations is indicated on a magnified scale by light reflected from a mirror that oscillates sensitively. The reflected light produces a white band that varies in length agreeably to the measure of vibration; and the red beam from the neon lamp serves to locate the position of the unbalancing factor. This, in very general terms, outlines the functioning of the dynamic balancing equipment.

Mr. Peter Davey, the inventor of the equipment, has furnished the following interesting examples of practical applications of his device. A turbo-generator on the *S. S. Leviathan* was giving a lot of trouble, and its vibrations were of sufficient magnitude to be annoying several decks above. After unsuccessful attempts to balance the machine it was decided to take out the rotor and to send it away to be balanced. This would have necessitated cutting holes in a number of decks, and would have been a rather expensive procedure. An early model of the Davey equipment was applied to that job; and the vibration trouble was cured in a few hours without removing the rotor.

An electric company built some 175-hp. motors for ventilating sets in submarines. These motors presented difficult balancing problems, as they included fan rotors that ran at about 5,000 revolutions per minute. Again, the dynamic balancing equipment made it possible to quickly correct the trouble. As a contrast in speed and size, a frequency changer with two coupled rotors, each weighing more than 100 tons and running at the rate of 310 revolutions per minute, developed a very bad condition of unbalance; but by means of the Davey equipment these rotors were put in smooth-running shape with only four changes of weight.

An interesting example of how the device can be used for diagnostic purposes was a certain turbine that showed a vibration of great magnitude. The Davey equipment revealed that this vibration was only partly due to unbalance. Another cause was therefore sought; and the equipment disclosed that it was attributable to an exhaust pipe. That





Left—Traveling case and principal apparatus of the Davey dynamic balancing equipment. Right—This picture shows how the Davey dynamic balancing equipment is packed for easy carriage.

pipe was in a direct line with the side of the turbine; but, even so, its vibrations were about 90 degrees out of phase with the latter. The pipe was readjusted on its foundations, and this had the immediate effect of reducing the vibration of the turbine and, at the same time, of indicating that there was only a small degree of unbalance in the machine.

FUEL OIL FROM NUTS

THE babassu tree, hitherto a little-known member of the coco-palm family, may become a subject for front-page news if it be a potential source of fuel oil, as has been suggested in a recent report from the Rio de Janeiro office of the United States Department of Foreign and Domestic Commerce.

According to that report: The oil of the babassu nut, besides comparing favorably with other edible vegetable oils, has exceptional calorific value. Its discovery by the outside world was mainly due to a shortage of fuel oil during the World War, when the ships in the Brazilian navy were fired with oil of that kind.

Heretofore, the tree and its products have served the natives of Maranhao and neighboring states of northern Brazil as food, shelter, clothing, fuel, and illuminant. It is also used there in the curing of rubber because of the creosotic properties of the smoke from the burning nuts. Estimates have placed the number of babassu trees in the State of Maranhao—where it flourishes—at 200,000,000.

JOHANNESBURG WIDENS HER STREETS

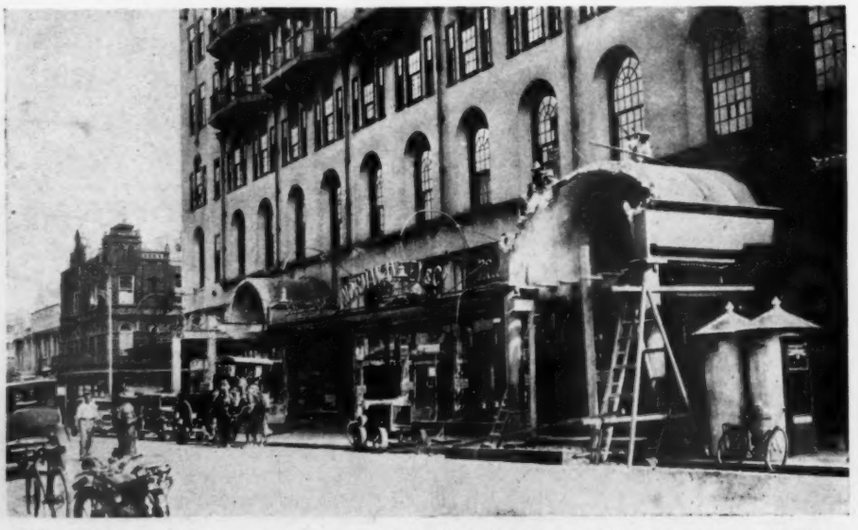
JOHANNESBURG, South Africa, is responding to an insistent demand for more space on the part of the motor vehicles that traverse the busiest thoroughfares of that city. Dwellers in the populous municipalities of the United States are familiar with such a situation, brought to pass by the ever growing volume of motor traffic, but they are probably unaware that the same problem has developed in South Africa where the per capita ownership of automobiles and motor trucks is much lower than it is in America. However, we live to learn.

We have recently been informed by a Johannesburg correspondent that many of the streets in that attractive city have had their roadways widened in order to provide much needed room for the community's motor vehicles. To make this space available, the authorities have been obliged to encroach on the area heretofore assigned to sidewalks; and

Close-up of one of the brick and reinforced-concrete archways in the course of demolition.

in some instances the sidewalks have been narrowed to half their original widths. This, of course, is a far simpler solution of the difficulty than cutting away the fronts of flanking buildings so as not to restrict the space available to pedestrians. Even so, alterations have been forced upon the owners of some business structures.

Two arched entrances or covered ways to one of Johannesburg's large department stores extended from the facade out to the curb. When the sidewalk was narrowed, it was necessary to remove these obstructions of brick and reinforced concrete, which was very tough and difficult to break up. This was done with paving breakers operated with compressed air supplied by a Type Twenty 4¼x4-inch portable compressor. With these facilities the demolition of the archways took about eight days' time, much less than would have been required had the work been done by hand.



The removal of these covered ways constituted but a small part of an extensive program of street-widening in Johannesburg, South Africa. A portable compressor and paving breakers were used to do the work.

SEISMOGRAPH TO HELP ROADBUILDERS

THE seismograph, primarily designed to register earthquakes, has been used to indicate earth tremors due to other causes. During the World War, for example, that delicate instrument was utilized by some of the belligerents to record shocks due to gunfire for the purpose of determining the range and the position of enemy batteries. Now we learn that the seismograph is making it possible to study the effect of heavy motor traffic on hard-surfaced roads.

The Standard Oil Company of California has placed a number of seismographs along certain highways in the West, and is thus recording the vibrations set up in those highways by passing automobiles. They are arranged so as to measure, simultaneously, the extent of the vertical and the horizontal earth movements. This data, it is believed, will do much to explain the striking differences in the service lives of various kinds of roads; and will enable us to so improve our existing highways that they will be equal to traffic demands for a considerably longer period without the need of repairs.

NEW COOLING FLUID FOR AIRPLANE ENGINES

INCREASED airplane efficiency is promised through the use of a new motor cooling fluid that has been developed in the laboratories of the Army Air Corps Material Division at the Wilbur Wright Field, Dayton, Ohio. Tests have proved that the substitution of ethylene-glycol for water in the engine radiator will give a plane not only more speed but also better climbing qualities and greater maneuvering capacity, besides measurably decreasing the consumption of fuel and oil.

As compared with water, ethylene-glycol has a boiling point of 387° F., or 175° more than that of water; and 1 quart of it will serve the purpose of 1 gallon of water—no inconsiderable saving in weight where the load that can be carried is, of necessity, limited. In commenting on the change in cooling fluid, Brig. Gen. William E. Gilmore, Chief of the Army Material Division, has said:

"The full results in actual flight tests will not be known until new planes, aerodynamically designed for higher temperature cooling, are built. However, our calculations and wind-tunnel tests indicate an increase in speed of from fifteen to eighteen miles an hour over the planes equipped with radiators designed to hold water."

America Has Grown Air Conscious

What Has Been Done in the Past Quarter Century in the United States to Advance Aviation

By R. BURDETTE DALE, M.E.

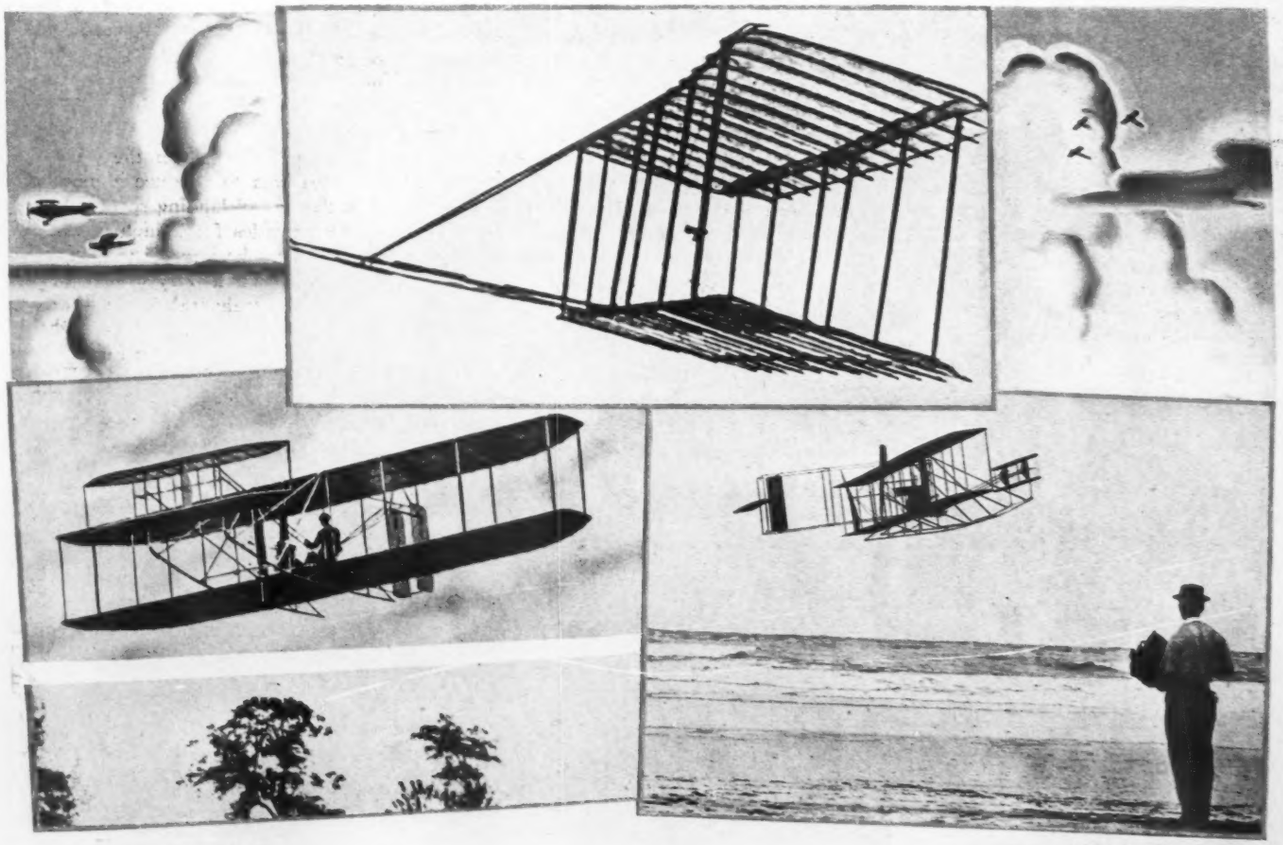
ONE of the most remarkable developments in America in recent years has been the commercial use of the airplane. Beginning with feeble attempts during the early part of the twentieth century, which culminated in the successful experiments of the Wright Brothers in 1903, man is now able to satisfy his age-old desire to fly as a bird. The first flights covered a distance of only a few hundred feet. Now, the airplane has taken its proper place as a commercial reality in the United States.

Each day, thousands of miles are flown over established airways by planes carrying United States mail, passengers, and express matter. Night flying over illuminated air courses is an accomplished fact. The hazards of weather have been largely overcome. Rare, indeed, are the occasions when the transcontinental mail fails to come through on schedule.

On December 8, 1903, the airplane designed by Prof. Samuel P. Langley, Secretary of the Smithsonian Institution, Washington, D. C.—carrying Charles M. Manly as pilot and driven by a 5-cylinder, radial, gasoline engine designed and built by Manly—crashed in its take-off from a houseboat into the Potomac River. On the 14th of that month, on Kill Devil Hill, Kitty Hawk, N. C., Wilbur Wright made a flight of 105 feet—attaining an altitude of about 15 feet and staying aloft for a period of 3½ seconds. This he accomplished with an engine-driven airplane designed and built in coöperation with his brother Orville. The flight ended in a crash. Three days later, on December 17—the accepted and official date of the first successful flights of an engine-propelled airplane, the Wright Brothers made four flights, in the fourth attempt covering 852 feet in 59 seconds. The 25 years which have passed since may well be said to have been epochal, because they mark the beginning of a new day in the progress of science and engineering as they affect humanity.

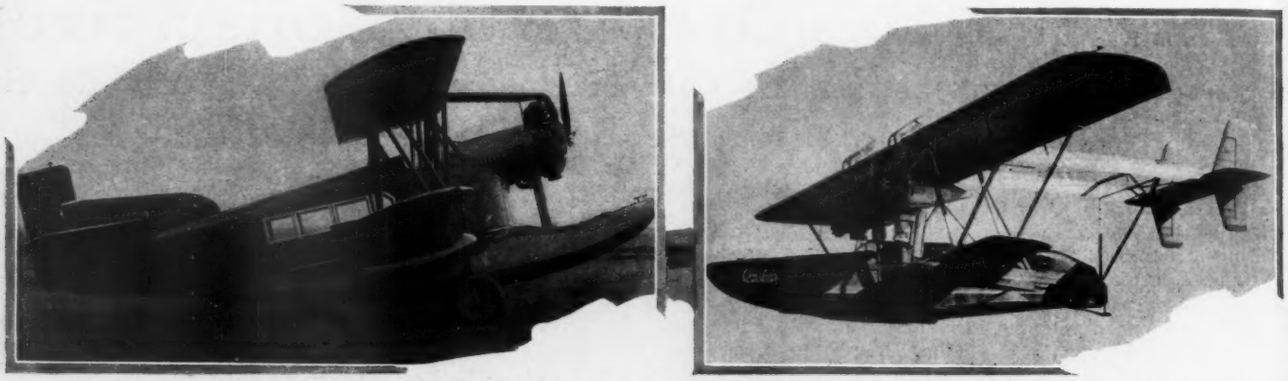
Among the pioneers in aviation are many illustrious names. During the nineteenth century, Cayley, Peacock, Hensen, Stringfellow, Wenham, Boulton, Penaud, and Gauchet made notable contributions towards solving the problem of flight. Otto Lilienthal, a German scientist, did much to advance the art with his glider experiments, which began in 1891. He made nearly 2,000 free flights in the Rhinow Mountains, about 100 miles north of Berlin. They demonstrated that it was practicable for man to fly; and they were an inspiration to the Wright Brothers who, later, made free flights in gliders of their own construction before trying to go aloft in an engine-propelled plane. Lilienthal taught others to fly, including Pilcher, Herring, and Wood.

Doctor Langley was the first man to establish the principles of mechanical flight upon a scientific basis. He started on his studies of the problem in 1887, and in 1891 published his *Experiments in Aerodynamics*. Three years later, he gave to the world *The Internal Work of the Wind*. In 1896, Langley built and tested a power-driven model



Wide World Photos

Top—Glider constructed and used by the Wright Brothers in mastering some of their first problems in mechanical flight. Left—One of the Wrights flying over the tree tops when demonstrating their machine before United States Government officials. Right—The Wrights' first engine-driven plane in flight at Kitty Hawk, N. C., in 1903.



Left—Keystone-Loening cabin amphibian air yacht. Right—Sikorsky cabin "sesquiplane" in flight.

equipped with a steam engine which weighed 30 pounds. The test of the *Aerodrome*, as it was called, took place on May 6, 1896, on the Potomac River about 30 miles below Washington. The machine did not carry a pilot. Dr. Alexander Graham Bell, who saw the demonstration, reported that the model rose to a height of 80 or 100 feet and remained aloft for about 1½ minutes.

Some years after its unsuccessful trial in December of 1903, the man-carrying, power-driven Langley airplane was reconditioned, provided with a new engine, and, with a few minor changes, flown at Hammondsport, N. Y. Those trials proved the airworthiness of the machine. Lateral stability was obtained principally by means of the dihedral angle between the wings; but, because of the lack of adjustable control surfaces, an unusual degree of skill was required on the part of the pilot to handle the plane.

The Wright Brothers, having taught themselves to fly at Kitty Hawk, proceeded to construct a power-driven airplane. They carefully studied the propeller, using two of slow speed but remarkably high efficiency in their successful machine. They designed and built for it a gasoline engine; its wings were of the biplane type; and lateral stability was obtained by warping the trailing edge of the wings in a manner similar to that of a bird in flight.

Glenn H. Curtiss, who resided at Hammondsport, formed a company in 1901 to manufacture motorcycle engines. In 1907, with Doctor Bell, J. A. D. McCurdy, F. W. Baldwin, and Lieut. Thomas Selfridge, Mr. Curtiss formed the Aerial Experiment Association at Hammondsport. They designed and constructed a biplane, named the *Red Wing*, and equipped it with a Curtiss motor. The plane's two wings were of reverse dihedral form—that is, the upper wing was curved downward while the lower wing was curved upward. Many modern machines have positive dihedral angles to improve lateral stability.

The *Red Wing* was provided with runners so that it could take off from the ice. It was the first airplane to make a public flight in America. Piloted by Baldwin on March 17, 1908, it rose from the ice on Lake Keuka and made a flight of 319 feet. It was wrecked in landing, which is not surprising considering the fact that the *Red Wing* had the most primitive of landing gear. The next Curtiss machine, the *White Wing*, had a wheeled undercarriage; and on May 8, 1908, piloted by McCurdy, made its initial public flight in America—the first in this country of an airplane starting from the ground.

On July 4 of that year Curtiss won the Scientific American trophy at Hammondsport, flying a distance of 1 kilometer, about ⅝ mile, in his *June Bug*. This was the first American machine to be equipped with hinged ailerons at the wing tips, and was of the pusher type. The aileron is universally used in modern airplane design to obtain adequate lateral control. If the ailerons, which now take the form of hinged flaps on the trailing edge of the wings, are held in a neutral position they have no effect upon the equilibrium of the plane. However, if the aileron on one side is raised while the opposite one is lowered, the effect is to tilt or "bank" the plane sidewise or to rotate it about its fore-and-aft axis. They are under the control of the pilot and permit him to tilt the plane when making a turn or to put it on an even keel. The use of wing-tip ailerons on the *June Bug* was a notable step forward, although the Wright Brothers had already accomplished the same thing by warping the trailing edge of the wing. On September 12, 1908, at Fort Meyer, Va., a Wright machine made a record flight of one hour, fourteen minutes, and twenty seconds, attaining a speed of about 40 miles per hour.

An especially interesting experiment was made by Doctor Bell, who designed and built a plane patterned after the tetrahedral kite. His idea was to produce a machine with a slow flying and landing speed. While such a design provides for a high aspect ratio, the resistance to the forward motion of the plane through the air is very great. The machine had 3,960 tetrahedral cells covered with red silk; and McCurdy made a flight in it at Baddeck, Nova Scotia, on February 22, 1909.

In December of 1908 the Curtiss *June Bug* was transformed into a hydroplane by substituting a boat for the wheeled undercarriage. It was rechristened the *Loon*, and

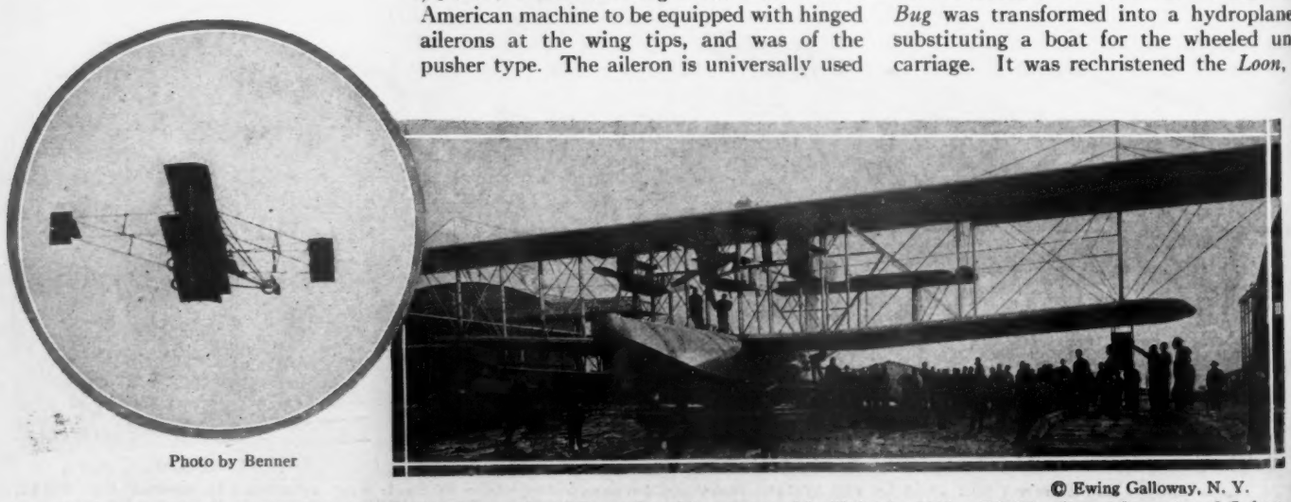


Photo by Benner

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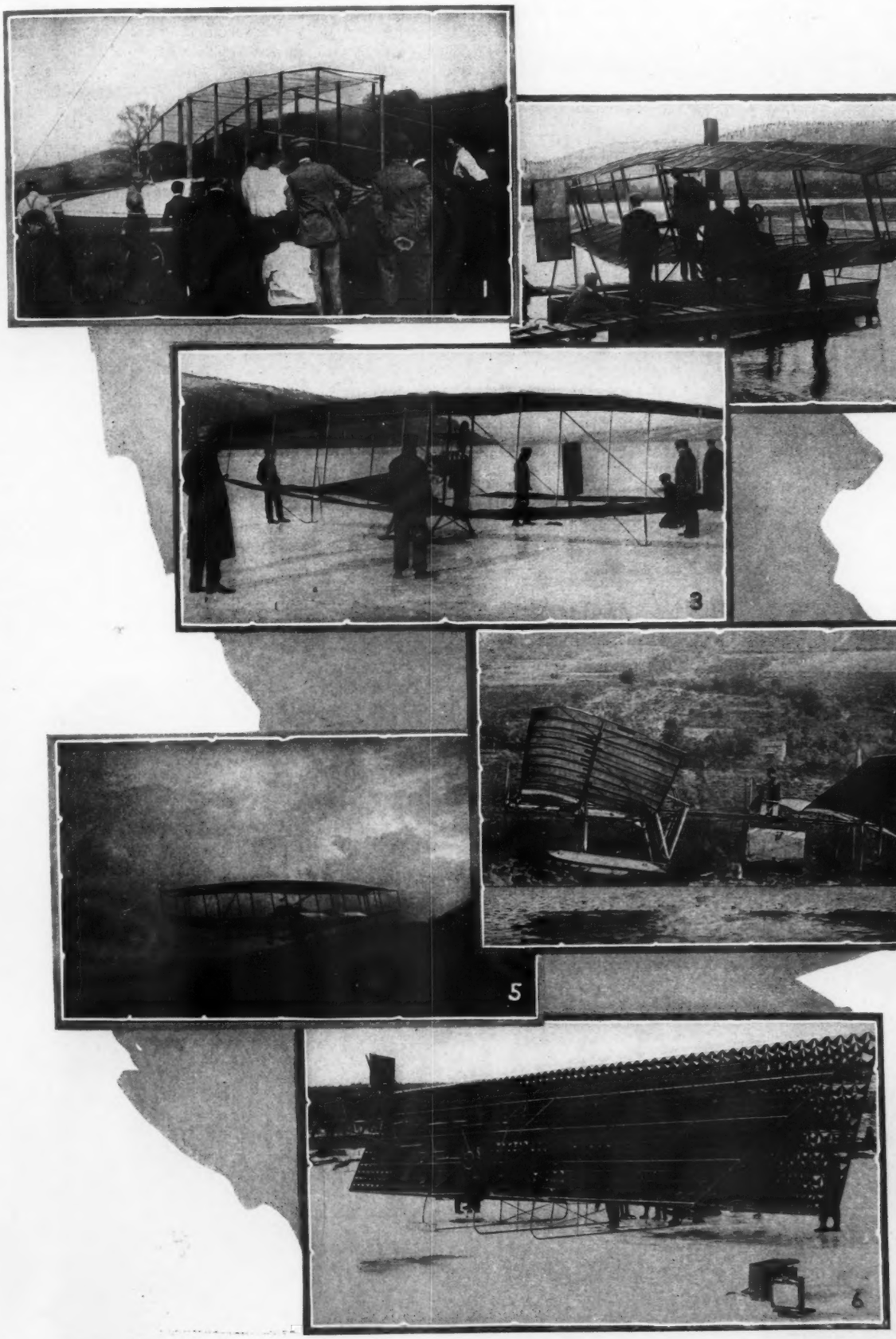
Left—Curtiss preparing to make a landing at Sheepshead Bay after his memorable flight in 1910. Right—Great 3-motored flying boat "NC-1". One of this class made the transatlantic flight from America to Portugal in 1919.



Photos by Benner

1—Curtiss "White Wing" at Hammondsport, N. Y. Plane mounted on a wheeled undercarriage. 2—The "Loon", the first Curtiss hydroplane. 3—Curtiss "Red Wing" on the ice at Lake Keuka, N. Y. 4—Langley airplane in flight above Lake Keuka in 1911. Lieut. E. Doherty, pilot. 5—The "June Bug", with Glenn Curtiss at the controls. First plane to be provided with hinged allerons. 6—"Cygnet No. 2", Dr. Alexander Graham Bell's tetrahedral cell-type flying machine at Baddeck, Nova Scotia.

tried out on the waters of Lake Keuka. A similar Curtiss plane, called the *Silver Dart*, made a flight of fourteen miles over the ice at Baddeck on March 2, 1909. Between 1903 and 1908 considerable progress was made abroad, and in 1906 Santos-Dumont made a public flight of about 700 feet in a power-driven airplane. The names of Farman, Bleriot, and Voisin are connected with this period.

To get a complete grasp of the development of the airplane in America, one must recount the story of its motor. In many respects, the engine used by the Wright Brothers in their plane flown at Kitty Hawk on December 17, 1903, was remarkable. Orville and Wilbur Wright, who had a small bicycle repair shop in Dayton, Ohio, had made a 2-cylinder, 2-hp. motor in 1899. Efforts to buy an engine suitable for their flying machine being unsuccessful, they started, in 1912, to build a 4-cylinder unit which they thought would weigh 200 pounds and develop 8 hp. When finished and tested it developed 12 hp. at 1,090 revolutions per minute and weighed 179 pounds including an 18-pound magneto. This they used in 1903 at Kitty Hawk. Subsequent improvements brought the developed horsepower of this engine, which had a bore of 4 inches and a stroke of 4 inches, up to 25 hp. at 1,300 revolutions per minute.

In 1906, the Wrights constructed a new motor which had a bore of 4⅜ inches and a stroke of 4 inches, developed 39 hp. at 1,600 revolutions per minute, and weighed 180 pounds. This engine was employed by them in their first public flights in France and at Washington, D. C.

When Curtiss was 23 years old—in 1901, to be exact—he began building motorcycle engines, for he was especially interested in motorcycle racing. He developed a light, powerful, high-speed, sturdy, and reliable motor. Six years later, with one of his engines, he established an unofficial record of a mile at the rate of 137 miles per hour at Ormond Beach, Fla. This record was not beaten for ten years. The *Silver Dart*, shown in one of the accompanying illustrations, was equipped with a Curtiss 8-cylinder, water-cooled, 50-hp. motor which was built in 1906. With this engine, and representing the Aero Club of America, Curtiss won the Gordon-Bennett trophy in 1909, establishing a world's record for an airplane flight at 46½ miles per hour. It is of particular interest that the "high velocity" then was less than the stalling speed of many present-day planes.

The engine designed and built in 1902 by Mr. Manly for the Langley airplane, and which is on exhibition at the Smithsonian Institution, is of the radial type having five cylinders of 5-inch bore and 5½-inch stroke. The connecting rod assembly was of the master-rod type similar to that now used in the Curtiss "Challenger", the Wright "Whirlwind", and the Pratt & Whitney "Wasp" engines. Manly later became a designer for the Curtiss company.

The period from 1909 until the United States entered the World War was marked by many epoch-making exploits in the air. The United States Army Curtiss scout plane of the *JN* class was one of the first machines of the fuselage, tractor type. In the model illustrated, the water-cooled engine is mounted in the nose of the fuselage in front of the pilot's seat—an arrangement adding greatly to comfort and safety. In the event of a crash, there is no danger of the engine breaking loose from its mounting and pinning down the pilot. It will be noticed that the airfoil of the *JN* class is thin but that, in contrast with earlier wing sections, its top and bottom surfaces are covered. Scientific experiments with wind tunnels had by this time indicated the nature of the lifting power of the airplane wing and proved that the vacuum produced on the upper surface was more effective than the pressure on the lower surface of the airfoil.

In 1914, Curtiss built for Rodman Wanamaker the now famous *America*, which was intended for a transatlantic flight. The war

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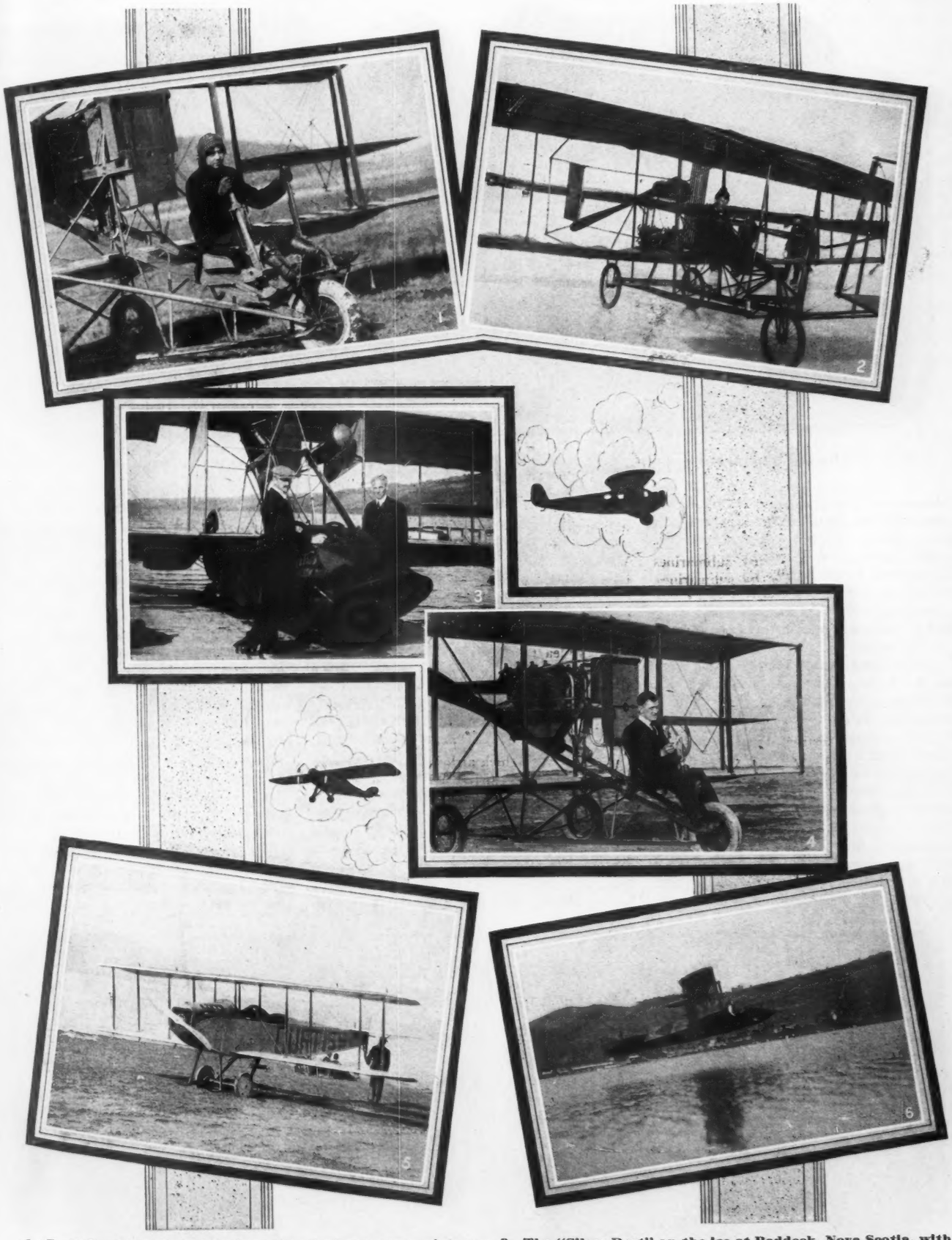
1—Loading heavy parcels into a plane of the Stout Air Services, Inc. Lines operate between Detroit, Cleveland, Chicago, and other cities. 2—Americans are now saving time by flying between cities of the Middle West. 3—This is a Curtiss "Robin" capable of carrying two passengers, a pilot, and a liberal amount of baggage or light freight.



1—Ruth Law, one of America's earliest daring women aviators. 2—The "Silver Dart" on the ice at Baddeck, Nova Scotia, with J. A. D. McCurdy at the controls. 3—The "King of the Road" and the "King of the Air", as Henry Ford referred to himself and Glenn Curtiss when this picture was taken. 4—Lincoln Beachy in the airplane with which he looped the loop in 1912. 5—Curtiss scout plane of the "JN" tractor type. 6—Curtiss flying boat at Lake Keuka, with the designer at the controls. Note the location of the ailerons between the wings.

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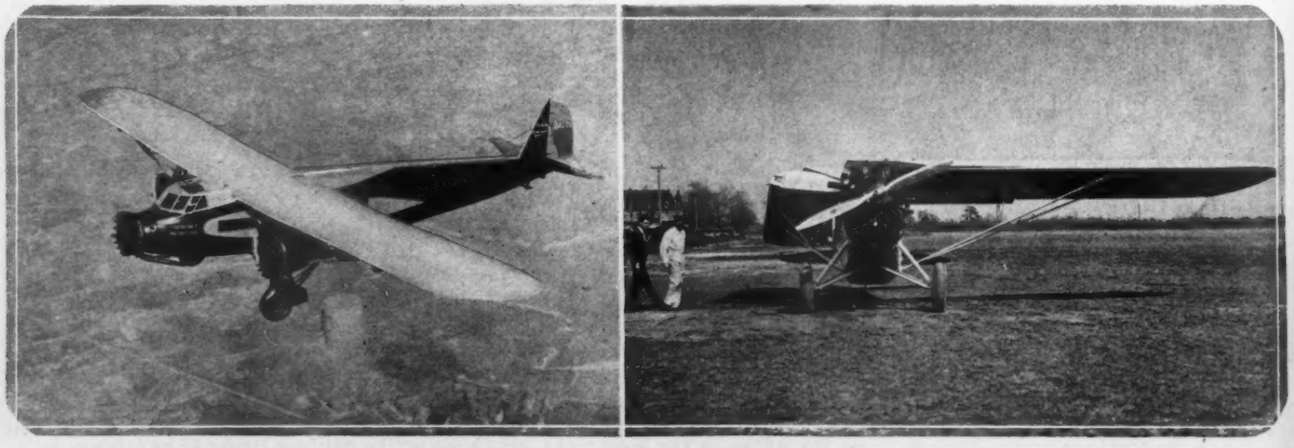
Colonel Lindbergh's famous monoplane, "The Spirit of St. Louis", leaving the hangar at Curtiss Field, Long Island, on May 20, 1927, to hop off on its memorable Paris flight.

interferred with the plans, and the plane was purchased by the British Admiralty and used in coast defense. It was reported that the *America* destroyed three enemy submarines and prevented many attacks by submarines on troop transports. The *America No. 1* and the *America No. 2*, constructed the year following, were the forerunners of the famous *NC* flying boats. The *NC-1*, a 3-motor seaplane, had a wing span of 126 feet and a wing chord of 12 feet. On November 27, 1918, at Rockaway, N. Y., this machine carried 50 men aloft. In all, four planes of this type were built. After testing, the hull of the *NC-2* was found to be impractical, and further trials with this ship were abandoned. On May 8, 1919, the *NC-1*, *NC-3*, and *NC-4* left Rockaway in an attempt to cross the Atlantic. The *NC-1* came down in a rough sea off Newfoundland, but Lieut. Bellinger and his crew were rescued by a passing steamer. After a forced landing on the surface of the ocean, the *NC-3* taxied 209 miles to Ponta Delgada. The *NC-4* flew to Horta, Azores, and on May 27 landed in Lisbon, Portugal.

The progress in aviation during the World War both in the United States and abroad is exceedingly interesting, but it is impossible here to record the scope of those developments. During those years, Dr. Hugo Junkers produced the thick airfoil wing section. It was his idea to design a wing structure that would be self-contained, thus eliminating much of the external bracing, wires, and struts which had heretofore been used. Anthony G. H. Fokker followed in Doctor Junkers' footsteps and designed many wartime pursuit planes with thick airfoils for the German army. The thick airfoil is an improvement which has been adopted for machines of modern design, particularly of the monoplane type.

Col. Charles A. Lindbergh took off from Roosevelt Field, Long Island, on May 20, 1927, and landed at Paris 33½ hours later, having made a non-stop transatlantic flight of 3,610 miles at an average speed of about 108 miles per hour. This was accomplished in a Mahoney-Ryan plane designed by Donald A. Hall. Close upon the heels of that achievement, on June 4, Clarence D. Chamberlin and Charles Levine started from Roosevelt Field and landed at Helfta, near Eisleben, Saxony—thus establishing the first non-stop flight across the Atlantic with a passenger. Twenty-five days later, Commander Byrd with Acosta and Balchen made still another transatlantic flight, coming down in the sea near Ver-sur-Mer on the coast of France. On the 28th of that month, Maitland and Hegenberger, in a Fokker army transport, left Oakland, Calif., and arrived at Wheeler Field, Hawaii, 2,400 miles distant, after a flight of 25 hours and 15 minutes. These conquests of the air naturally aroused great public interest in aviation in America.

Since 1927, many new records have been made and broken and, at this writing, the United States claims the palm for endurance



Left—Keystone "Patrician" in flight. Right—Fairchild cabin monoplane with hinged wings to facilitate packing for transportation. Commander Byrd carried one of this type for South Polar service.

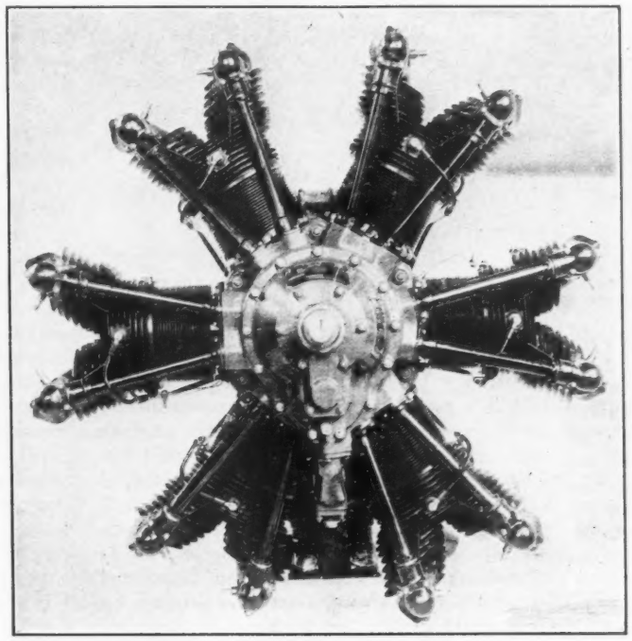
flying while the Germans hold the world's record for altitude. At the end of May, last, Willi Neunhofer, in a Junkers plane, wrested the world's altitude record from Lieut. A. Soucek, U. S. N., by climbing to a height of 42,123 feet, almost 3,000 feet above that reached by Lieutenant Soucek in his Wright-Apache seaplane. On July 30, Dale Jackson and Forrest O'Brine, in their Challenger-engined monoplane *St. Louis Robin*, remained in the air for a period of 420 hours, 21 minutes, and 30 seconds—beating the previous continuous-flight record of the biplane *Angeleno* by 173 hours, 37 minutes, and 58 seconds.

One of the most modern examples of overland commercial transport airplanes in service in the United States is the Keystone *Patrician*. This is a tri-motor cabin monoplane, accommodating eighteen passengers and a crew of two, and is provided with a private sleeping compartment and a refrigerating system. This machine attains a maximum speed of 155 miles an hour and has a cruising speed of 130 miles.

The seaplane also has been highly developed. One of the accompanying photographs shows a Sikorsky "sesquiplane" in flight. This is a 2-motor cabin plane carrying nine passengers in addition to its crew of two. It is called a sesquiplane because its lower wing has a span equal to about half that of the upper wing. Its high speed is between 124-128 miles per hour; its cruising speed, 110-112 miles per hour; and its landing speed, 55 miles per hour.

The present status of aviation cannot be fully covered by merely going into the advance in the art of designing and building planes. To complete the picture, it is necessary to say something about our commercial activities. The Aeronautical Chamber of Commerce reports that in the United States during 1928 a total of 52,934 passengers was carried over commercial airways for a distance of 10,472,024 miles. This represents a 100 per cent increase in mileage over 1927, and a 420 per cent increase in passenger traffic. The Department of Commerce has made the following report of United States commercial airway activities as of March 30, 1929:

	Miles
Airways operating	21,392
Mail airways operating	18,074
Additional airways scheduled for early operation	2,161
Additional mail airways scheduled for early operation	4,376
Total airways operating and scheduled for operation	27,929
Daily average mileage of mail planes in operation	39,216
Daily average mileage of non-mail planes in operation	18,300



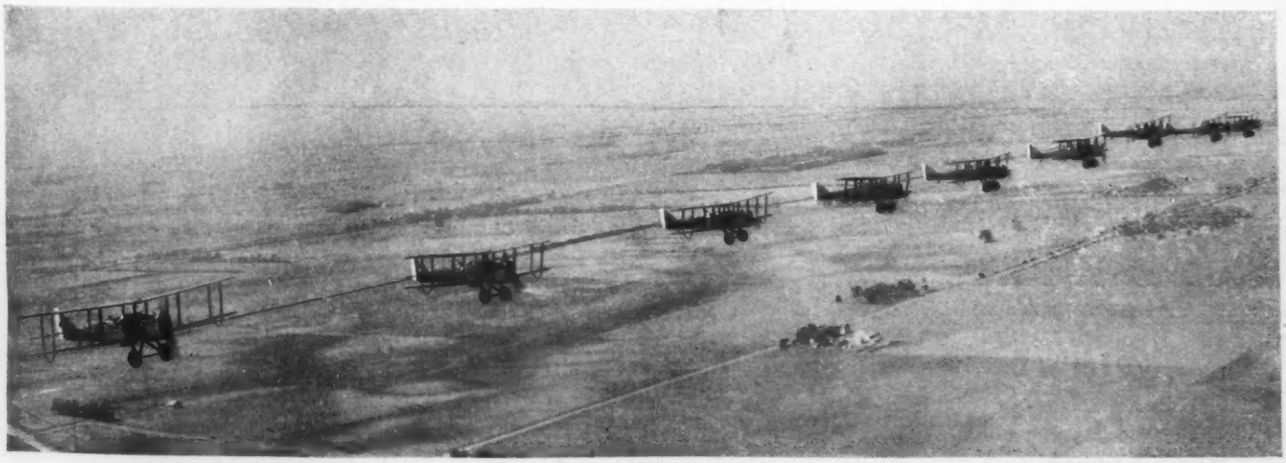
Curtiss "Challenger" 170-hp., radial, air-cooled engine. Something radically different from the type of motive power used in the early days of aviation.

Mail now leaves New York City at 8 p.m. and Hadley Field at 9:35 p.m., generally arriving at Los Angeles at 4:15 a.m. and at San Francisco at 4:30 a.m. the morning of the second day. From the halting and extremely modest beginning in 1903, when the Wright Brothers made their first flight at Kitty Hawk, to the present-day safe, speedy, and scheduled service of our airways, is a scientific and engineering achievement of amazing magnitude. Directly or indirectly, aviation now touches everyone.

A recent development in transportation in the United States is the combination rail-and-air service. It is now possible, for example, for a traveler to leave New York at night by rail and, upon arrival at Cleveland the next morning, to continue his journey westward to Chicago by airplane, thereby measurably reducing the time that would be required if the entire trip were made by rail. Such a coast-to-coast rail-and-air service has been inaugurated by the Pennsylvania and the Santa Fe railroads.

The first officially recognized flight in America, made only a little more than 25 years ago, covered a distance of 852 feet. Today American planes are flying an average daily distance of 57,516 miles and carrying thousands of passengers and many tons of express and mail matter. Because the United States is a land of great distances with widely separated centers of population and industry, combined with the demand for rapid means of communication and transportation, the further development of aviation in this country is assured.

An 80-mile highway across Japan is being advocated by the country's leading business men. The proposed road is to connect Yokaichi, on the Pacific coast, with Tsuruga on the Sea of Japan.



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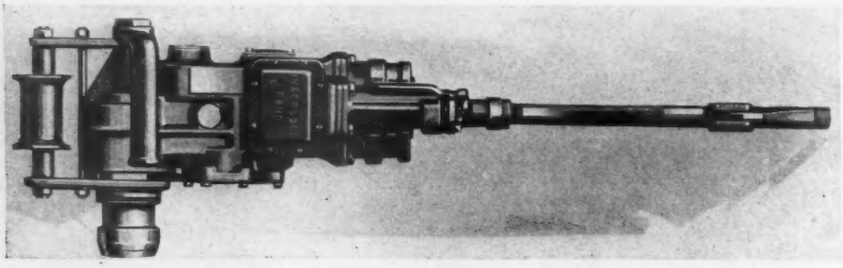
Battle formation of De Havilland fighting planes. Every machine is holding its exact position in the line.



The new heavy-duty Ingersoll-Rand track wrench will run off or tighten securely the largest sizes of track bolt nuts.

NEW HEAVY-DUTY PNEUMATIC TRACK WRENCH

THE shops of the Ingersoll-Rand Company have developed a new or improved tool in its Size 99C track wrench for backing off or running on track bolt nuts. In this air-operated wrench the makers have given the maintenance-of-way man a machine that is 50 per cent more powerful than the older types and, yet, one more easily handled.

Regarding the outstanding structural details of the Size 99C the manufacturers have this to say: The air motor is of the reversible, 2-cylinder, double-acting type that gives the wrench a flat and compact appearance. A single valve, gear driven at half the crank speed, is used. The gear drive results in exact valve timing and in low valve speed, which tends to reduce wear. As the valve operates under balanced air pressure, causing it to float in the valve bushing, the wear on these parts is still further reduced.

Power from the motor is transmitted to the spindle through an efficient and rugged train of gears—the final drive being effected through a heavy herringbone gear with a backbone. There is no weakening relief groove in the center of the herringbone gear, which operates smoothly and silently.

The wrench has sufficient torque to pull the nut up tight, and therefore does away with the need of going over the work—that is, giving each nut a final twist with a hand wrench. When the nuts on one joint have been run up, the wrench can be easily moved along on the rail because it is equipped with a wheel. Another feature that makes for speed in service is an improved type of chuck that slides readily over the nut; and the handle grip, located at the spindle end, likewise aids in spotting the wrench. The throttle handle has been lengthened to give greater leverage; and it is S-shaped so as to keep the operator's hand away from the ties and to put the throttle where it can be conveniently manipulated. For backing off nuts, the direction of rotation of the wrench can be reversed by means of a lever at the motor end of the tool.

It is claimed for the new heavy-duty bolting machine that it can run off or tighten securely the largest sizes of track bolt nuts, and that it can do the work of from five to eight hand wrenches.

According to reports from Copenhagen, some rich deposits of gold and silver ore have been discovered near Reykjavik, Iceland.

SETTING POWER-LINE POLES WITH DYNAMITE

AS a preliminary to setting power-line or other heavy poles it is usually the practice first to excavate the necessary holes. But down in the Florida everglades a new method of pole-setting has been tried out and, it is claimed, with marked success. The innovation is the idea of a foreman of the Florida Power & Light Company, who discovered that if a pole is set vertically in position on top of the ground and a charge of dynamite exploded at a predetermined depth directly beneath it, the pole will settle quietly to the depth at which the charge is placed. Needless to remark, considerable practice is required to secure satisfactory results under varying conditions.

In the case of the Florida swamp lands, across which many miles of transmission lines have been run, the wood poles are erected as follows, according to *Engineering and Contracting:* A piece of 1½-inch pipe is worked into the ground by using a ½-inch rod as a plunger—the weight of two men, applied through pipe wrenches, being sufficient to cause the pipe to settle. After reaching the required depth, the plunger is removed and several sticks of dynamite are dropped into the pipe and pushed to the bottom. In hard ground, or in ground which may clog the pipe, a blasting point is utilized. This is screwed to the pipe to permit the latter's withdrawal. With that done, the pole is erected over the charge ready for the blast. Anywhere from three to twenty sticks may be needed, the charge depending upon the character of the soil and the depth to which a pole of given weight and size is to be sunk.

Apparently, the weight of the pole is sufficient to prevent an upward thrust; and the gases which form the cylindrical cavity serve to cushion the pole in its descent. In case the pole comes to rest before the bottom of the hole is reached, the drill pipe is worked under the butt at an angle and another charge inserted—the result of the first charge determining the quantity of dynamite to be used for the second one. With the exercise of a little judgment, no difficulty should then be experienced in getting the pole lodged firmly.

OAKLAND-ALAMEDA TUNNEL SPRAY PAINTED

THE painting of 27,000 square yards of walls and ceiling in seventeen working days is something of an accomplishment. This was done by the use of the paint-spray method in preference to brush work in the case of the Oakland-Alameda vehicular tunnel, which was opened to traffic not long ago.

This tunnel, under an estuary of San Francisco Bay, has created a great deal of interest in engineering circles because it is the first of its kind to be built in a drydock—that is, precast in sections, each 203 feet long, which were towed into position, sunk, and joined underwater. The tube is 4,436 feet long and has a diameter of 32 feet. The inner surfaces and hand rails are painted white; and a broad yellow stripe divides the roadway into two traffic lanes.

Section of the finished Oakland-Alameda vehicular tunnel which was painted in record time by the air-spray method.

Work on Ambassador Bridge Goes Forward Rapidly

This Great Structure Across the Detroit River Will Promote Travel Between Canada and the United States

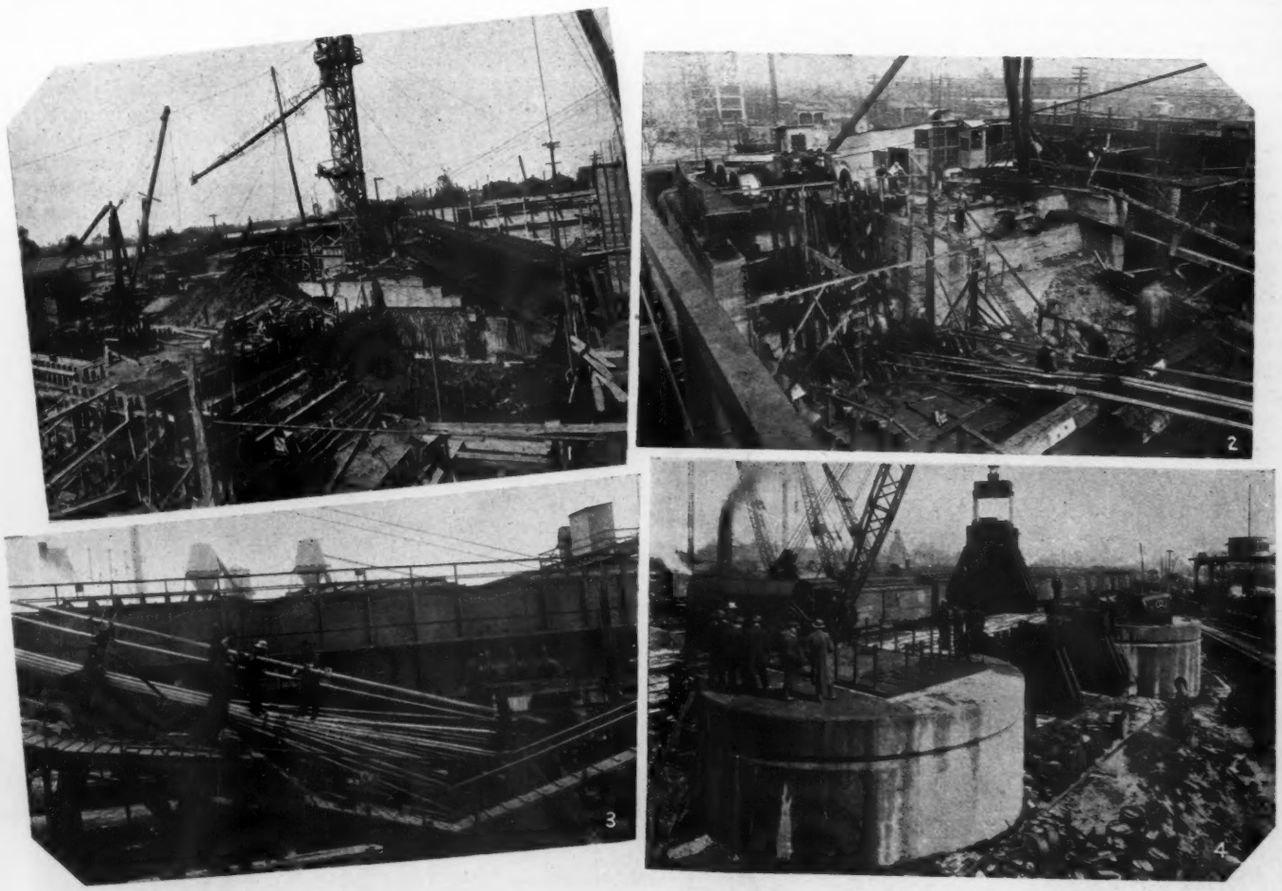
By S. G. ROBERTS

AMBASSADOR Bridge is the singularly appropriate name that has been chosen for the monumental structure that soon will span the Detroit River between Detroit, Mich., and Sandwich, Ont. While Sandwich and Detroit will be the immediate beneficiaries of this steel bond that will unite the two shores of this much traveled and historic international stream, still the whole of Canada and the United States will be the gainers through the means so provided for greater and freer neighborly intercourse.

The point where the bridge overhangs the river is where the opposite banks are conveniently close to each other and where the Indians crossed the waterway long before the white man came to America. Thus the peoples of the present day are following, so to speak, where the redman blazed the way in the centuries gone. The Ambassador Bridge will give material form to an urge that has been recurrent for decades, and which has in the past led to a number of projected solutions of a problem that has grown steadily greater as the nearby communities in Canada and the United States have increased in population and importance. For more than half a century, plan after plan was suggested, but none promised well enough to meet existing and prospective conditions until the Ambassador Bridge was conceived.

The Detroit River is traversed by a tremendous volume of water-borne freight and by many passenger steamers; and this movement of shipping has been greatly augmented in latter years. Such being the case, earlier projects were turned down because they were likely to interfere with river traffic or would eventually do so; and the problem remained unsolved until the Detroit International Bridge Company and The Canadian Transit Company joined efforts and were duly empowered to go ahead with the type of structure represented by the Ambassador Bridge.

As might be expected, the automotive vehicle has emphasized the need of a bridge between Detroit and the opposite Canadian communities of Windsor and Sandwich. Notwithstanding the fact that ferry service between Detroit and the "border cities" has expanded rapidly, still the demand has increased even faster, and vexatious delays occur at peak periods—especially during the rush movements on holidays or at summer weekends. Furthermore, weather and seasonal conditions obstruct or hamper the operation of the ferries—causing tantalizing and serious



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1—An advanced stage of the work on the anchorage piers at the Canadian end of the Ambassador Bridge. 2—Fastening main-cable strands to anchorage eye bars at the United States end of the Ambassador Bridge. 3—Assembling a single strand of one of the main cables. 4—Placing the first of the steelwork on the main piers for the tower on the United States side of the Detroit River.

interruptions to the progress of business and pleasure vehicles and to the travel to and fro of the peoples of the two countries. This brief summary of the situation should make it more apparent what a boon the Ambassador Bridge is likely to prove.

The plans of the Ambassador Bridge were approved by the United States War Department and the Governor General of Canada in the spring of 1927, and early in May, following, actual work was started with appropriate ceremonies. On the United States side of the river, a stake was driven at the tower site by Miss Helen Austin, daughter of J. W. Austin, treasurer of the American Transit Company; and operations were initiated on the Canadian side of the river on June 23, when the Mayor of Sandwich, Alexander McKee, turned the first shovelful of earth. The construction contract was signed on July 20, 1927; and by the terms of that instrument the bridge was to be ready for service by August 1, 1930. In all probability, this date would have been anticipated by the better part of a year had not the engineers decided to replace the main cables after they were in position.

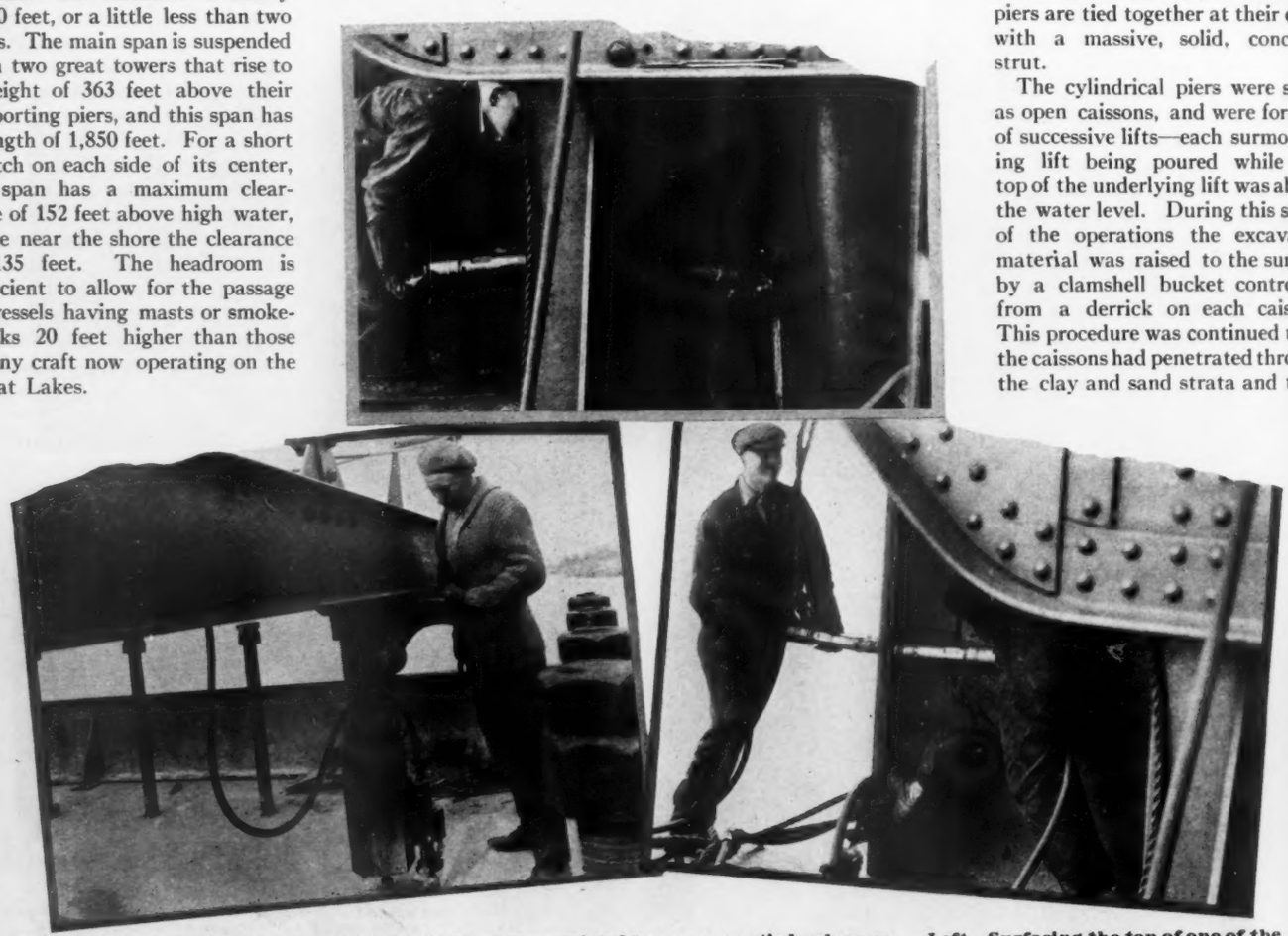
Exclusive of its associate terminals, the structure of the Ambassador Bridge has a length of about 7,400 feet; and from the entrance of one terminal to the exit of the other terminal the distance is nearly 9,000 feet, or a little less than two miles. The main span is suspended from two great towers that rise to a height of 363 feet above their supporting piers, and this span has a length of 1,850 feet. For a short stretch on each side of its center, the span has a maximum clearance of 152 feet above high water, while near the shore the clearance is 135 feet. The headroom is sufficient to allow for the passage of vessels having masts or smokestacks 20 feet higher than those of any craft now operating on the Great Lakes.

Each main tower comprises two steel columns that are adequately bound together by suitable cross-bracing that insures a proper measure of rigidity to meet wind and loading stresses. Each column is composed of three large rectangular cells that are riveted together to form, in effect, a single unit. Within these cells are ladders that make it possible to inspect and to paint all interior surfaces so as to safeguard against the development of unsuspected structural defects or impairment by reason of corrosion. The load on each column due to the cable carried on top of it is about 9,000 tons, and to this must be added the column's own weight, which brings the burden to 10,000 tons as delivered upon the underlying pier.

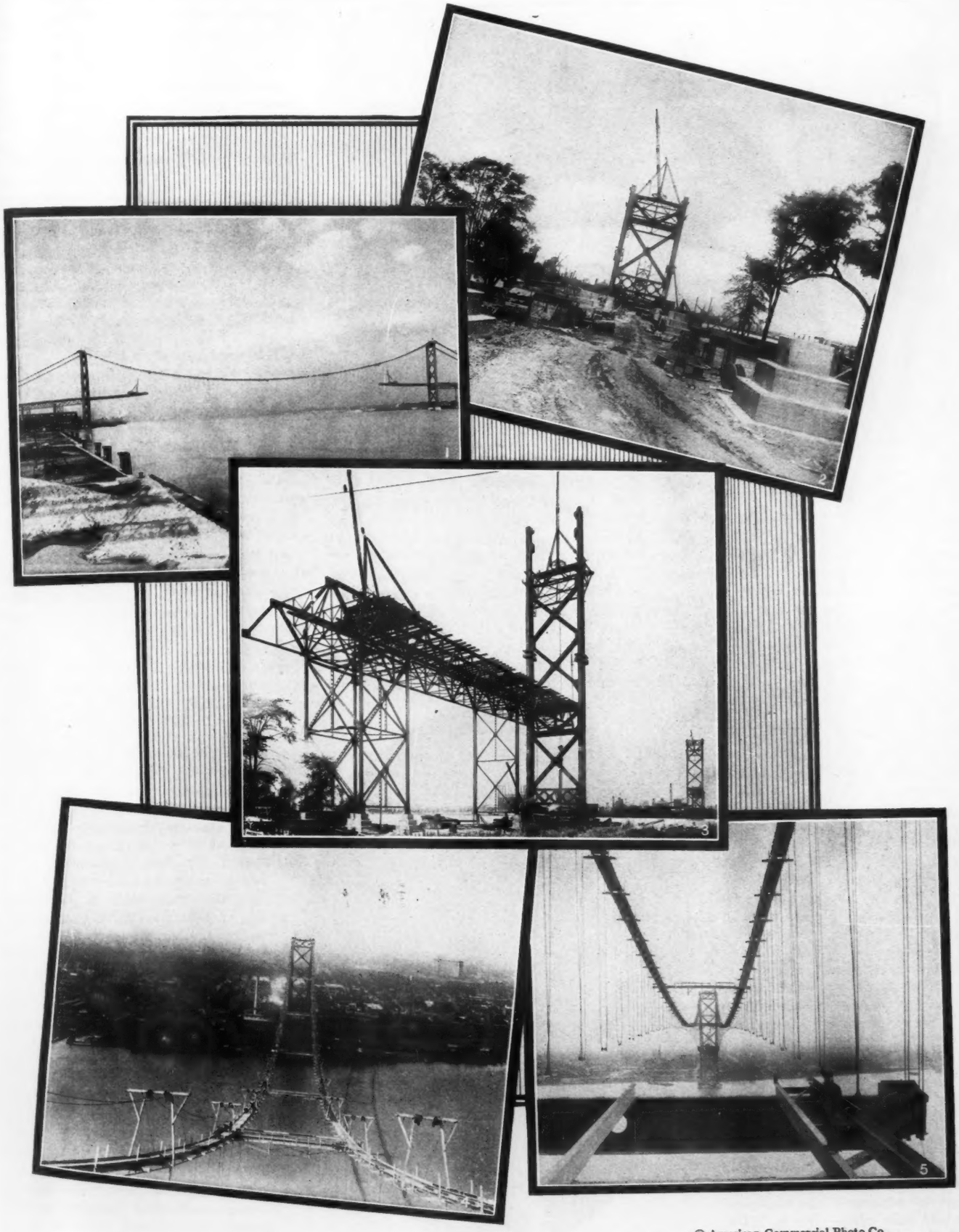
The two columns of each main tower are placed 67 feet apart, from center to center, and this disposition leaves space for a roadway, 47 feet wide, that will be marked for five traffic lanes. The assignment of certain of these lanes for service will depend upon the direction in which the greater volume of traffic may be moving at a given time. A single 8-foot walk on the west side of the bridge will be used by pedestrians. The structural arrangement of the span is such that a person driving over the bridge, even when passing between the tower columns, will have a feeling of spaciousness; and the open sky will be visible virtually all the while. This desirable effect is due to the care exercised in arranging certain of the structural features. The top lateral bracing, so often seen, has been omitted in the case of the Ambassador Bridge; and the needful lateral stiffness has been provided in the top chords by making the vertical posts stiff members transversely to the center line of the bridge. The trusses have a depth of only 22 feet, because the effect of cable distortion under load has been considered in the design. The trusses are built of silicon steel to save weight; and this metal can withstand higher working stresses than the steel ordinarily used for this purpose.

The two piers for the tower on the Canadian side of the river are offshore 250 feet, while the corresponding piers on the United States side are inshore a little more than 70 feet from the harbor line. All four piers rest upon bedrock—which is limestone—at a depth ranging between 105 and 110 feet below the level of the river. Each pier is a hollow cylinder of reinforced concrete 38 feet in diameter from bedrock upward for a distance of 96 feet, and from there on to the top—20 feet higher—it is 29 feet in diameter. The piers have 10-foot walls, and each has an 18-foot shaft that was utilized during the sinking of these caissons. The 29-foot circular caps are of solid concrete; and the two piers are tied together at their caps with a massive, solid, concrete strut.

The cylindrical piers were sunk as open caissons, and were formed of successive lifts—each surmounting lift being poured while the top of the underlying lift was above the water level. During this stage of the operations the excavated material was raised to the surface by a clamshell bucket controlled from a derrick on each caisson. This procedure was continued until the caissons had penetrated through the clay and sand strata and their



Top—Driving heavy rivets with an 8A riveting hammer assisted by a pneumatic bucker-up. Left—Surfacing the top of one of the main concrete piers with an air-operated surfacer. Right—Double-gunning with Ingersoll-Rand riveting hammers in driving large rivets in a main tower.



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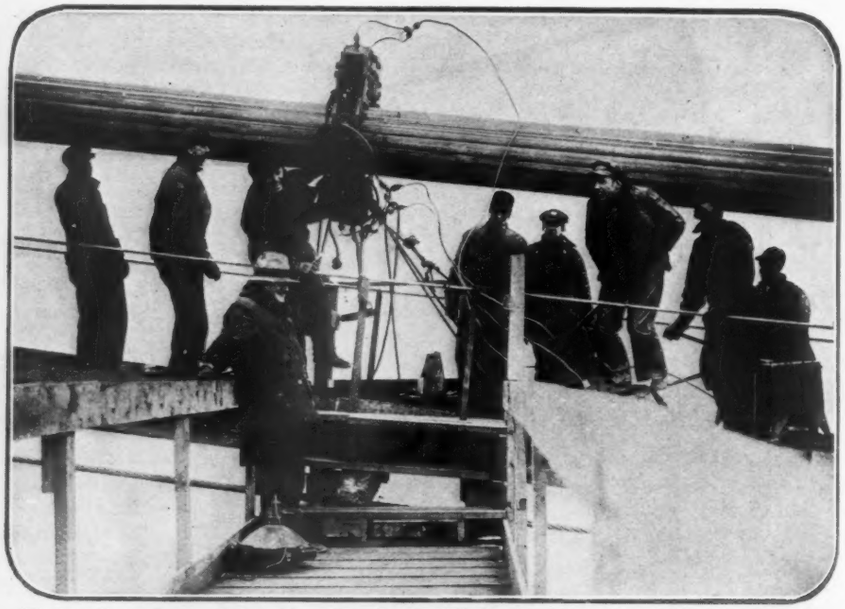
1—This picture was taken before the original main cables were removed and at a time when part of the steelwork of the roadway projected above the river from both main towers. 2—Approach piers on the Canadian side ready for the erection of the steelwork. 3—Partly completed main tower and associate steelwork on the Canadian side of the river. 4—Catwalks used by the workers in assembling the main cables high above the sweep of the Detroit River. 5—Hanging the steelwork of the roadway to the suspenders pendant from the main cables.



Hydraulic press used in squeezing the multiple strands into a cylindrical cable. One of the operations in assembling a main cable.

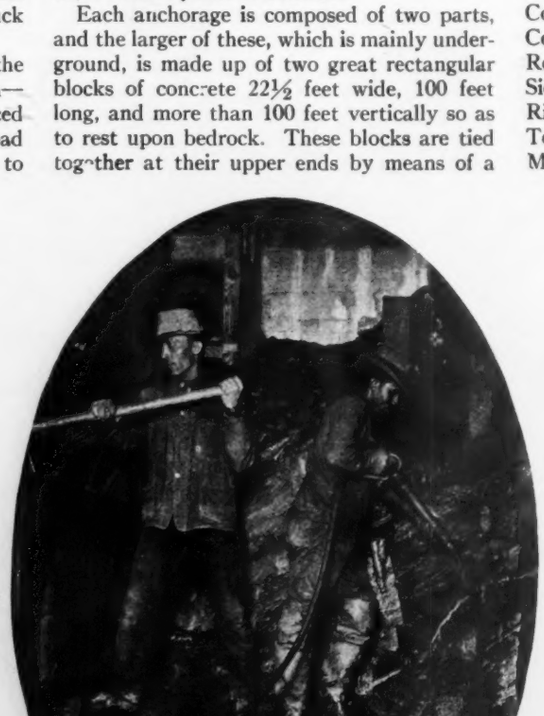
cutting edges were in contact with the underlying hardpan. Open dredging was then no longer possible, and it became necessary to equip the caissons with air locks and to work them under compressed air. Small cylindrical buckets were used thereafter to lift the muck through the material shafts.

The sinking of the caissons through the hardpan was accomplished by blowing them—that is to say, the air pressure was reduced in the working chambers and the dead load of the caissons then became great enough to force the cutting edges into the hardpan to the extent desired. This reduction in air pressure was, on occasions, continued for half an hour—the cutting edges gradually penetrating the hardpan the while and coming to rest so well embedded that little if any sand and water could seep into the working chamber.

The excavating of the sticky clay, when passing through that material, proved rather difficult until Ingersoll-Rand air-driven clay diggers were utilized; and I-R paving breakers were later on employed to deal with the hardpan when that was encountered. Operating air for these tools and for the I-R riveting hammers subsequently used on the steelwork of the bridge has been furnished on the Detroit side of the stream by two 9x8-inch ER-1 compressors.

Each of the four main piers contains approximately 8,000 cubic yards of concrete. Inshore from the pier caissons, on each side of the river, are the two anchorages for the two main suspension cables. Each of these anchorages are designed to withstand the combined pull of both main cables—that is, 16,000 tons; and, to this end, each anchorage is a great mass of reinforced concrete that rests upon the deeply buried limestone bedrock. The anchorage on the United States side contains about 22,000 cubic yards of concrete, while the anchorage on the Canadian side of the international stream is made up of 18,000 cubic yards of concrete.

Each anchorage is composed of two parts, and the larger of these, which is mainly underground, is made up of two great rectangular blocks of concrete 22½ feet wide, 100 feet long, and more than 100 feet vertically so as to rest upon bedrock. These blocks are tied together at their upper ends by means of a massive superstructure of reinforced concrete 36 feet through from top to bottom, 50 feet across from front to rear, and 114 feet long from end to end. The rectangular blocks were sunk as caissons and built up as they sank in successive lifts. The caissons were brought to rest in the hardpan, and the underlying material was excavated down to bedrock—the cavity so formed being filled with concrete to bind each caisson to the supporting limestone. The hardpan was broken loose, for hoisting to the surface, with air-operated paving breakers. Each caisson had four shafts through which the muck could be handled.



Air-driven Ingersoll-Rand clay diggers were utilized effectively in getting the big caissons down to the underlying bedrock.

Each of the two main cables, when compacted and wrapped, will be substantially 19⅜ inches in diameter; and 8,066 separate steel wires, each about as thick as a lead pencil, will be assembled to form a finished cable strong enough to carry its share of the static and the maximum live loads for which the bridge is designed. The estimated normal live load will be 1,650 pounds per linear foot, while the congested live load will be twice as great. Possibly, a better conception of the magnitude of the bridge and its associate features can be had if we tabulate the approximate quantities of the principal materials entering into the undertaking's get-up. These are:

Structural steel and cable wire, tons.	24,000
Concrete masonry, cu. yds.	25,000
Cement, bbls.	40,000
Roadway pavement, sq. yds.	60,000
Sidewalk, sq. yds.	8,000
Rivets driven	2,000,000
Terminal buildings, cu. ft.	540,000
Maximum number of laborers simultaneously employed in the field	550

The estimated cost of the project has been placed at $22,000,000.

Because of the international character of the Ambassador Bridge, it has been necessary to make provision for inspection by the respective customs and immigration departments of the two governments concerned and, at the same time, to facilitate the rapid handling of vehicular traffic even at peak periods. Therefore, each terminal will be a small town in itself. The terminal in Detroit will cover an area of 6 acres while the one in Sandwich will have an area of 7½ acres. The detention areas in the terminals will have a parking capacity ample for 300 vehicles undergoing or awaiting examination—this will obviate the obstructing of any of the lanes assigned to main-line traffic. According to calculations, it will be possible to handle through either terminal as many as 5,000 vehicles in the course of an hour.

By using the Ambassador Bridge, through traffic from points on the line between Fort Wayne and Detroit en route to Niagara Falls will save from 10 to 137 miles, depending upon the road chosen. This traffic will avoid the

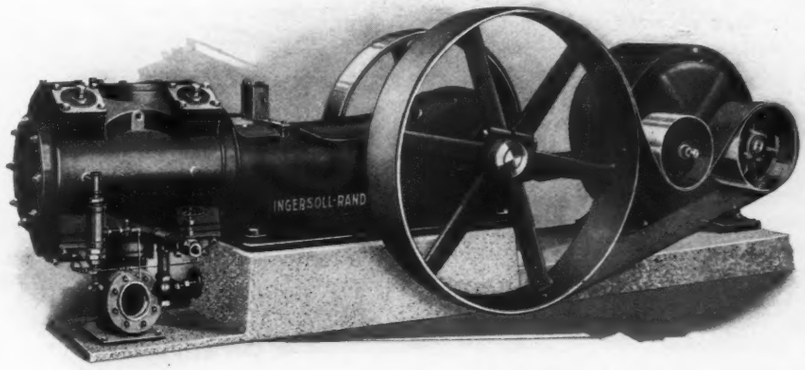
congestion of such busy cities as Toledo and Cleveland. Traffic for Canadian cities, such as Hamilton, Toronto, Ottawa, and Montreal, will enjoy a much shorter route than has been available heretofore. The Ambassador Bridge will be a toll bridge; and the greater part of its revenue will be derived from passenger automobiles and motor buses. The buses are counted upon to carry a large percentage of the 13,000,000 persons who now cross the Detroit River by ferry annually.

Up to the present time the tolls to be charged have not been definitely established, and probably will not be until shortly before the bridge is opened for service. However, the authorities have announced that in no event will single-trip tickets for other than commercial vehicles be in excess of fifty cents, including the driver, and five cents for each additional passenger. The maximum rates for buses and commercial vehicles of various weights are yet to be announced. Commutation tickets will be sold, and this will make it possible for frequent or regular users of the bridge to obtain substantially lower rates than will be charged for single-trip tickets.

Apart from its monumental proportions and the way in which the two tall towers dominate both river fronts during the daytime, the Ambassador Bridge will not lack as a spectacle throughout the hours of darkness. This will be achieved principally by surmounting the top of each steel tower with a Claude neon electric sign. One will face the United States side of the river while the other will front the Canadian shore. Each sign will be 75 feet long, and the illuminated letters will be 6 feet high. Motorists, therefore, will have no rouble in locating the approaches to the bridge when miles away. It is believed that the glowing letters will be visible to boats on Lake Erie soon after passing Russell Island, more than twenty miles distant. According to the computations of the electrical engineers, each neon sign will require 2½ kw. of current, or about the same amount consumed by twelve standard 200-watt lamps.

As has been well said: "Along the broad highway of this bridge, commerce, the life blood of nations, shall flow; and through its wide portals thousands shall pass, carrying with them the ideas and the ideals of two peoples, to be exchanged for the common good."

The concerns and experts connected with the Ambassador Bridge are as follows: the McClintic-Marshall Company. Pittsburgh, Pa., specifications for masonry, metal superstructure, and pavements; consultants for the Detroit International Bridge Company, Messrs. Modjeski & Chase, New York City; and consultants for the general contractors—that is, the McClintic-Marshall Company—Messrs. Monsarrat & Pratley, Montreal. Subcontracts were awarded as follows: Foundation Company, main and auxiliary piers and anchorage substructure; Keystone State Corporation, wire cables and hand and suspender ropes; H. H. Esseltyn, Inc., United States terminal walls and auxiliary piers of engine-house group; Walbridge Aldinger Company, United States viaduct approach piers; Merlo, Merlo & Ray, Ltd., Canadian approach foundations and terminal walls; John V. Gray Construction Company, Ltd., Canadian terminal buildings—terminal walls—viaduct pavement, slabs, curbs, and sidewalks; W. E. Wood Company, United States terminal buildings—anchorage superstructure—viaduct pavement, slabs, curbs, and sidewalks—truss-span pavement, slabs, curbs, and sidewalks; main-span pavement, slabs, and sidewalks; Canadian Bridge Company, Ltd.. steelwork of Canadian viaduct approach. Ernest Clarke, Ltd., Canadian anchorage superstructure and truss-span pavement, slabs, curbs, and sidewalks; John Meehan & Son, granite-block paving of United States approach; and the Zipp-Beckmeyer Construction Company, exterior lighting system



Compressors of this type and size are furnishing air for various operations in connection with the construction of the Ambassador Bridge.

Pneumatic paving breakers proved useful in removing the hardpan so that the caissons could rest on the solid limestone.

MAKING TRAIN STOPS "ON THE FLY"

SOMETHING in the nature of a feat in railroading is reported from London by United States Trade Commissioner Harold A. Burch, who states in *Commerce Reports* that certain British express trains drop coaches at intermediate stations en route without coming to a halt. For example, travelers for Westbury, Taunton, and Exeter—which are not scheduled stops on the daily run of the Cornish Riviera Express from Paddington to Plymouth, can now board that train and journey to their separate destinations in special coaches provided for them. These coaches are at the end of the string of cars, and are successively "slipped" or left behind by the moving train. Ordinarily but one "slip coach" is carried; the Cornish Riviera Express is the only one to accomplish the feat of dropping three.

This is achieved by a so-called slipping apparatus which effects the uncoupling and the braking of only the special coaches—the disconnected air-brake line and the heating pipe being in each case automatically sealed. Apparently, the system is making it possible to give the traveling public increased express service upon lines already carrying all the traffic that they could accommodate under ordinary circumstances.

A collapsible pontoon for ship salvage has been invented by a Swedish engineer to facilitate handling in transit.

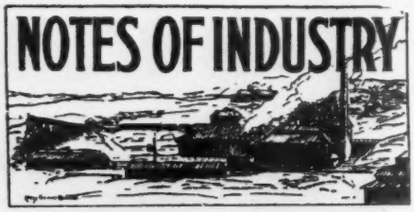
WHEN IT IS PROFITABLE TO TURN NIGHT INTO DAY

FOOL Old King Sol by doing certain outdoor work at night during hot weather! This has been tried, and with success, in a large Texas stone quarry which experienced considerable difficulty in keeping the men on the job in the pits during the day because of the extreme heat which prevails in that state during the summertime. When the situation became so acute as to threaten the suspension of operations, the management hit upon the idea of reversing the order of affairs—working during the cooler hours of the night. The men readily agreed to that plan.

With that part of the problem solved, the next question was how to illuminate the quarry adequately—the nearest sizable town being too remote to furnish power for electric light. Portable flood lights burning acetylene gas were obtained. These could be shifted and handled readily by the men—the fuel consumed being supplied in the form of cakes of processed carbide. These "Carbic" lamps served well to simulate daylight conditions.

DRAWING PAPER-THIN TUBES OF COPPER

THE making of thin seamless copper tubing is an achievement claimed by the Winchester Repeating Arms Company, which is now turning out on a commercial scale tubes about 1 foot long and from ¼ to ⅜ inch in diameter. By a process of so-called cold extrusion, cup-shaped pieces of plastic copper, ½ inch long and ½ inch wide, are transformed under a pressure of 50,000 pounds into paper-thin tubes in one-fifteenth of a second. These tubes are used for automobile and airplane radiators and for heat appliances of a new form. While the extrusion process of making seamless tubing is not new, it is the first time it has been applied successfully on a large scale to any metal as hard as copper.



First-aid telephone stations for the benefit of the motoring public are being set up by the German authorities along some of the main highways traversing rural districts. They are spaced about three miles apart; and are to be operated in conjunction with service stations open day and night.

Those of you who have hunted around in the dark for street numbers, as well as those who have been disturbed by the hunters, will second the motion that all sizable communities follow the example set by Stockholm, Sweden. That city has recently passed an ordinance to the effect that all house numbers be lighted electrically. Experts have been asked to draw up plans for the necessary wiring.

It sounds like a fairy tale, but Prof. Otto Quelle, of the Bonn University, is responsible for the statement that entire streets in Bahia, Brazil, are literally paved with amethysts—the waste produced in cutting the gems, and that there is a place in Siberia where opals are so plentiful that the coarser grades are used for road material.

Great interest attaches to the discovery of tin in the Shatford Lake and Bernic Lake districts of Manitoba, because it is the first find of that metal so far made in Canada. Extensive exploratory work by well-known mining interests has been started in the region, which is said to be very rugged and inaccessible.

Work on the Manchester-Liverpool highway, which was sanctioned two years ago, has been taken in hand at an estimated cost of nearly $14,600,000. It will involve the demolition of more than 100 houses and the construction of 32 bridges spanning railroads and waterways. This new 25-mile road, which is considered one of the most important from a commercial standpoint in England, will have a width of 120 feet divided up into a 40-foot speedway, two 20-foot lanes for slow-moving traffic, two 10-foot sidewalks, and two grass verges, each 10 feet wide.

From only $256,428,000 in 1900, the export trade of our Gulf and adjacent ports has mounted to $1,323,083,000 in value in 1928. These figures include foreign shipments of domestic goods from all points between New Orleans and El Paso.

In 1927-1928 the West Indies produced 5,406,000 long tons of sugar, representing 33 per cent of the world's cane-sugar output.

Western Canada is making profitable use of straw, converting it into a building material called strawboard which can be used, it is claimed, in place of ordinary lumber. The raw product is subjected to a pressure of 100 pounds per square inch in a machine designed for the purpose; laced with wire; and turned out in boards 14 feet long, 5 feet wide, and 2 inches thick.

Cotton is being grown successfully in the Belgian Kongo.

What is claimed to be the world's largest lock is rapidly nearing completion at Ymuiden, Holland, the port at the entrance to the North Sea Canal which connects Amsterdam with the sea. The new lock has a width of 164 feet.

The United States Bureau of Public Roads estimates that motor vehicles in the United States in 1928 traveled approximately 137,000,000,000 miles. This is based on a consumption of 10,596,000,000 gallons of gasoline, allowing 12.9 miles to a gallon.

The tank steamer was first used in Russia and was the invention of Ludwig Nobel, brother of the inventor of dynamite.

With the completion of the Puebla-Vera Cruz highway in Mexico sometime before the close of 1929 there will be established a coast to coast trunk road extending from Acapulco via Mexico City to the Gulf of Mexico.

Canada leads the world in the production of newsprint paper.

The world's automobile industry broke all previous records in 1928 with a production of 5,203,139 cars, or 1,044,173 more than in the preceding year. The United States' share of the total output was nearly 84 per cent.

Herbert Photos, Inc.

Surf-speeding is one of the thrilling diversions at Venice, Calif., a famous beach resort of the Golden State. Mild air pressure is used to inflate the fantastic rubber sea monsters to which youth and beauty cling in the wild rides upon the tumbling coastal waters. If you are looking for excitement try surf-speeding.

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EDITORIALS

OUR ADVANCE IN AVIATION

THAT America has, indeed, become air-minded is amply evidenced not only by widespread interest in aviation but by the effects that our aeronautical efforts are having upon our economic interests and our doings in divers directions. Most of us have probably not reviewed these reflexes nor paused to consider the many ways in which they are manifested.

For years, mechanical flight was deemed so hazardous that pilots could not obtain accident or life insurance, and if obtainable the cost was well-nigh prohibitive. That situation was altered as flying became more general and it was possible for the companies to accumulate data upon which to base more moderate rates. The factor of safety has latterly been increased so substantially that a movement is underway that will, undoubtedly, lead to a marked reduction in existing rates. This, in itself, is a significant indication of the strides that have been made in aviation.

The newspapers now carry daily weather reports intended especially for the guidance of airmen—proof that mechanical flight is an established department of human endeavor; and production data show that American plants manufactured 4,346 planes of all types and for wide'y varying services in 1928, with a value at the factory of nearly $44,000,000. Aircraft engines built during the same period numbered 3,496, and were valued at $20,000,000. Probably nothing is more suggestive of progress in aviation than the way in which certain of our foremost railways are joining hands with air-transport concerns in shortening to an amazing extent the time required to journey from coast to coast across the expanse of the continent. It hardly seems necessary to remind the public of the splendid records being made continually by the Nation's airmail service. All these really wonderful things have been brought to pass within an astonishingly brief span of years.

In our current issue, we have an article that touches upon some of the high points of the science and the art of mechanical flight as exemplified here in the United States. These developments have come about since SAMUEL P. LANGLEY blazed the way a little more than a quarter of a century ago with his epoch-making studies and with his model steam-driven flying machine that confirmed his researches and demonstrated conclusively that man would be able to compete with the creatures of the air.

CORDILLERAS RECENTLY HOLED THROUGH

COLOMBIA can now boast a tunnel two miles long through the towering Cordilleras where that section of the Andes has stood from time immemorial athwart the highway that links the Pacific Coast with the interior of that South American country.

The tunnel in question has recently been "holed through" after work extending over three calendar years. This accomplishment is due to the energetic and skillful work of a Canadian engineering concern; and in a few months regular railway service will be established by way of this new route that has largely been made possible by the efficient performances of air-driven rock drills.

The City of Medellin, in the central range of the Cordilleras, is the foremost municipality in the Department of Antioquia; and travelers and merchandise bound to and from that capital have heretofore been moved over the mountains by way of La Quiebra Pass, the journey necessitating a number of transfers. For centuries goods were carried by mule trains; and only since the development of the motor truck have the plodding beasts of burden given way to the speedier facilities. Even so, motor transport of freight and passengers has been a tedious and a costly means of travel and traffic; and the climb and the descent of the range has not been free from hazards and operating difficulties. The tunnel now nearing completion will change all this and add greatly to security and to speed in covering the run between Medellin and points on the Pacific Coast. It pierces the Cordilleras at an altitude of about 4,000 feet.

According to the *New York Times*, among some of the difficulties dealt with was the construction of a hydro-electric plant that operates under a head of 1,400 feet. That station has furnished motive power for the air compressors that, in their turn, have provided energy for rock drills and other pneumatic equipment used in driving the tunnel. Notwithstanding the remoteness of the job and numerous physical conditions of a hampering nature, the undertaking has gone forward with gratifying rapidity. Both the Colombian authorities and the contractor, so we are informed, are greatly pleased with the results. Here, again, we see how compressed air is doing its part in saving time and in accomplishing things that would be hard to achieve without its aid, and then only at an exorbitant cost.

CAN WE MAKE A GO OF IT?

TOWING tests have recently been conducted in the United States Model Experimental Basin, Washington, D. C., for the purpose of determining the best hull forms for two great liners that will be ready for service, under the Stars and Stripes, during the summer of 1932. These so-called "master ships" are intended to supplement the S. S. *Leviathan* in competing with the finest of foreign craft on the transatlantic run. The vessels will operate between New York, Cherbourg, and Southampton.

The keels of these liners, each of which will entail an expenditure of $25,000,000, will be laid, so it is reported, early in 1930 in one or possibly two of our foremost shipyards; and the intention is to so power the craft that they will be able to equal if not to better the speeds of any rival passenger ships. This is an ambitious program; and we wish those responsible for the plan all possible success. A similar project was contemplated something like ten years ago, but for one reason or another it was abandoned.

There is ample warrant for the belief that we have sufficient talent in this country to produce express steamers capable of doing all that foreign ships of that class can do. Heretofore, however, we have not sought to win the blue ribbon of transatlantic service; and one outstanding reason for our hesitation has been the much heavier operating cost under the laws controlling American ships. We naturally wonder how this difficulty is to be overcome or neutralized if these great ocean greyhounds are constructed.

SUGAR OFFSETS FATIGUE

WE, the people of the United States, used during the first half of the present year the enormous total of 6,574,400,000 pounds of sugar—representing a per capita increase of about 4.8 pounds over that consumed during the corresponding six months of 1928. These figures are both interesting and intriguing, because they raise a number of questions and stimulate the speculative mind.

Experts of various sorts—native and alien—have sought in different ways to explain our restless activities when engaged either in our daily occupations or in our frequent diversions. They all recognize that we are spurred on by some exaggerated impulse—judged by what other peoples do in like circumstances; but none of these savants are in accord. Such being the case, we ask in all humility: Hasn't the unusual amount of sugar consumed by us day in and day out something to do with our super-energy?

With only an elementary knowledge of the part played by sugar in our bodily metabolism, we are sufficiently informed to recall that sugar is a fuel that makes up the losses

incident to muscular effort. Why, then, should we not assume that the excess sugar in our diet is responsible for that degree of "pep"—as the vernacular has it—by which we are differentiated from the peoples of other countries. We know very well that mental alertness is impaired by physical fatigue; and if the body is keyed up for a spurt, why, then, should the mind not respond in kind and for the same reason?

Probably some of the wiseacres will shake their heads pathetically and charge us with crass stupidity; but, even so, we have no less an authority than the head of the Department of Psychology, Temple University, Philadelphia, Pa., to support our position in a general way. Dr. THADDEUS L. BOLTON, of that institution, has just completed researches designed to discover the cause of the mid-afternoon feeling of lassitude that manifests itself so commonly among workers in factories, business houses, and other places of endeavor.

Doctor BOLTON has found that an insufficient or improperly balanced diet will cause lassitude; and he advocates the timely eating of foods that, when taken in small quantities, will serve as quickly effective fuels for the bodily engine. A bit of candy, a piece of candied fruit, sweetened cold drinks, and sugar in hot ones, will do the trick. Sugar, then, can be used as an emergency ration for afternoon fatigue; and sugar wisely consumed regularly will not only offset fatigue but increase endurance under stress. And it is more or less under stress that we Americans live continually.

MASS PRODUCTION IN THE BARNYARD

BY inference, at least, the barnyard fowl of America are going in for mass production. Anyway, that is what the average person might be led to conclude from a report recently issued by the United States Department of Agriculture. The statistics broadcasted by that branch of the Federal Government reveal that the number of hens in the land has decreased 4 per cent during the year gone; but, despite this diminution, the output in eggs has been considerably larger than that previously recorded. Maybe this production betterment will not be reflected in lower prices; but the figures are heartening reassurance to those that look upon ham and eggs as preëminently the proper thing for a real man's morning meal. This is not the whole story of the chicken's response to modern conditions.

News has lately come from Omaha that a Doctor RENWALD has, after five years of experimentation, succeeded in evolving a brood virtually without wings or toe nails. Normal hens, so he is quoted, are bothered each year with the molting of their wing feathers, and when this occurs egg production falls off. The new breed should, therefore, not suffer from a similar interruption to their egg-laying; and it is estimated that they should produce an average of 300 eggs apiece each year. Having got rid of the toe nails as well as the wings, we wonder just how this modified chicken is going to do the scratching that has heretofore been so essential to the bodily welfare of barnyard fowl. May this factor not vitiate the good doctor's calculations?

ON THE BOTTOM, by Com. Edward Ellsberg, U. S. N. R. An illustrated volume of 324 pages, published by Dodd, Mead & Company, Inc., New York City. Price, $3.00.

THIS book is the recital of a battle with natural forces over a period of nine months in raising the sunken submarine *S-51* from the bottom of the Atlantic Ocean, where the stricken craft lay in wind-swept waters at a depth of 132 feet. It is the story of unfaltering courage on the part of the men that risked their lives often during that protracted struggle in order to achieve success in the end. Furthermore, it is a record of technical accomplishment and the utilization of special facilities—a number of them being spectacular in their nature and application.

The average layman knows next to nothing about the difficulties confronting the salvor engaged in such a task. There is a wide gap between the theoretical solution of such a problem and the execution of the hazardous work entailed. It seems little short of the miraculous that lives were not sacrificed in the undertaking—the margin of safety was frequently extremely narrow and the perils persistent and overabundant. Commander Ellsberg's book is a revelation of resourcefulness, tenacity of purpose, and unfailing intrepidity. Many and varied as were the mechanical facilities employed, these would have been of comparatively little avail had the men been dismayed at any time. It was their willingness and readiness to take risks, always with cool heads and steady nerves, that made the climacteric and seemingly impossible salvage of the *S-51* possible. We heartily commend this book to the reader seeking a thrill as well as to all who can appreciate the deeds of red-blooded men fighting against appalling odds.

SOMETHING ABOUT GAS LIFT, prepared by M. E. Nicklin. An illustrated book of 140 pages, published by the Waukesha Motor Company, Waukesha, Wis.

IN principle, the gas lift differs from the air lift only in that gas supplants air as the lifting medium. The air lift for pumping fluids is extensively utilized throughout the length and breadth of the country, and its virtues are well known. In the pumping of petroleum, however, natural gas is said to possess some advantages over air; and it is a matter of fairly common knowledge in the oil industry how important a part the gas lift played during the spectacular flush days of the Seminole Field.

Much useful information has been crowded into the four chapters of this admirably written book. These chapters deal separately with a general idea of the gas lift; actual practice; the economics of the gas lift; and with a summary embraced under the general heading, *What of the Future?* Any one interested in pumping oil wells should have a copy of this timely volume.

PRACTICAL RAILWAY PAINTING AND LACQUERING, by H. Hengeveld, C. P. Disney, and W. J. Miskella. An illustrated work of 267 pages, published by the Finishing Research Laboratories, Inc., Chicago, Ill., and distributed by Simmons-Boardman Publishing Company, New York City. Price, $3.50.

WHILE primarily intended to emphasize the economies made possible through the use of spray-painting outfits and air-operated portable cleaning equipment in the upkeep of railway rolling stock, railway bridges, and other railroad structures, much of the information in this book should be equally helpful to county supervisors, municipal authorities, state-highway engineers, mining engineers, and plant managers generally. We strongly recommend this book to all that have extensive painting to do periodically.

ELEMENTARY DIFFERENTIAL EQUATIONS, by Thornton C. Fry, Ph.D. A book of 255 pages, published by the D. Van Nostrand Company, Inc., New York City. Price, $2.50.

THE text of this book, which was evolved through several mimeograph editions in the Out-of-Hour Courses of the Bell Telephone Laboratories, is intended primarily for students of engineering and its allied sciences. The author's effort has been to stimulate interest by practical application, taking particular pains at the same time to promote a deep understanding of the logical principles involved. In short, to bring about a balance between the machinery of mathematics and the mental processes indispensable to their widest and most flexible use.

HANDBOOK OF ROCK EXCAVATION METHODS AND COST, by Halbert Powers Gillette. An illustrated volume of 325 pages, published by the Gillette Publishing Company, Chicago, Ill. Price, $6.00.

ONE has only to be reminded that millions and millions of tons of rock are excavated annually for many purposes to grasp the fact that work of this sort plays a considerable part in our industrial and engineering undertakings. It is important, therefore, that the ways and means employed to excavate, load, transport, and otherwise dispose of this rock must be such as to save money and time wherever practicable. The object of this excellent handbook is to describe the different kinds of rock encountered and what best to use in excavating them. The author has brought together in a compact form a great deal of helpful information.

Method and Cost of Mining Magnetite in the Mineville District, New York. This is Information Circular No. 6092 issued by the United States Bureau of Mines. The author, A. M. Cummings, has covered his subject in a thorough and authoritative manner.